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Application of a network perspective to DoD weapon system acquisition: an exploratory study

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MBA PROFESSIONAL REPORT

Application of a Network Perspective to DoD Weapon System Acquisition: An Exploratory Study

By: **Ryan D. Mantz**

December 2006

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One of the foundations of military command and control is that authority must match responsibility. Yet in weapon system acquisition, a program manager is responsible to deliver capabilities to the warfighter without full control of the resources he needs to carry out this task. Successful program managers recognize their dependencies upon other actors and execute their programs using a network with a common goal of enhancing a specific warfighting capability. A hierarchical chain of command still exists, but the network enables the actors to carry out their objectives in an efficient and effective manner. This report describes how acquisition process purportedly works in hierarchical terms. It also introduces a process model to describe the set of activities actually used and the actors who are required to collaborate to deliver capabilities to the warfighter. The analysis of those activities between actors reveals that weapon system acquisition behaves like a network. Describing acquisition in network terms allows those involved in weapon system acquisition oversight, policy, and practice to have a new insights and measurement tools to understand how to improve the weapon systems acquisition process.

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APPLICATION OF A NETWORK PERSPECTIVE TO DOD WEAPON SYSTEM ACQUISITION: AN EXPLORATORY STUDY

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Submitted in partial fulfillment of the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

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One of the foundations of military command and control is that authority must match responsibility. Yet in weapon system acquisition, a program manager is responsible to deliver capabilities to the warfighter without full control of the resources he needs to carry out this task. Successful program managers recognize their dependencies upon other actors and execute their programs using a network with a common goal of enhancing a specific warfighting capability. A hierarchical chain of command still exists, but the network enables the actors to carry out their objectives in an efficient and effective manner. This report describes how acquisition process purportedly works in hierarchical terms. It also introduces a process model to describe the set of activities actually used and the actors who are required to collaborate to deliver capabilities to the warfighter. The analysis of those activities between actors reveals that weapon system acquisition behaves like a network. Describing acquisition in network terms allows those involved in weapon system acquisition oversight, policy, and practice to have a new insights and measurement tools to understand how to improve the weapon systems acquisition process.

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LIST OF ACRONYMS

AFB	Air Force Base
AFMC	Air Force Materiel Command
APAT	Acquisition Process Action Team
CAE	Component Acquisition Executive
CDD	Capabilities Development Document
CJCSI	Chairman, Joint Chiefs of Staff Instruction
COCOM	Combatant Commander
CPD	Capabilities Production Document
DAB	Defense Acquisition Board
DAE	Defense Acquisition Executive
DoD	Department of Defense
DODD	Department of Defense Directive
DOT&E	Director, Operational Test and Evaluation
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities
FAA	Functional Area Analysis
HQ	Headquarters
ICD	Initial Capabilities Document
IPPD	Integrated Product and Process Development
IPT	Integrated Product Team
JCD	Joint Capabilities Document
JCIDS	Joint Capabilities and Integration Development System
JROC	Joint Requirements Oversight Council
MAJCOM	Major Command
MDA	Milestone Decision Authority
OIPT	Overarching Integrated Product Team
OMB	Office of Management and Budget
OSD	Office of the Secretary of Defense

OSD(AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics
PBD	Program Budget Decision
PEO	Program Executive Officer
PM	Program Manager
POM	Program Objective Memorandum
PPBE	Planning, Programming, Budgeting, and Execution
QDR	Quadrennial Defense Review
WIPT	Working-level Integrated Product Team

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I would like to thank my network of strong and weak ties that helped me to greatly expand my knowledge of the weapon system acquisition. My professors at the Naval Postgraduate School of Business and Public Policy provided a focus on the foundational elements, while my fellow students offered their wealth of knowledge and experience dealing with warfighting and acquisition.

My special thanks go to my advisers for this project, Professor Roberts and Professor Matthews. You helped me to shape my experiences and anecdotes into research and theory. I will never again look at the world of weapon system acquisition in the same way.

Finally, I would like to thank my wife, Becky, for her unwavering support. I utilized my kinship network in new ways. I never anticipated our relationship would deliver a List of References that I never could have typed with my broken arm.

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I. INTRODUCTION

A. PRELUDE

Over one-hundred years ago, the Wright Brothers were the first to accomplish a manned, controlled, heavier-than-air-flight, making history at Kitty Hawk, North Carolina, on December 17, 1903. How did two bicycle mechanics from Dayton, Ohio, accomplish this feat against a host of inventors? And, why did the Wright's lose their advantage and not continue to make aviation history? The answer to both questions revolves around their networks. Early on, the Wright's were not only inventors, they were networked innovators. Shulman concluded that their early success was due to their correspondence and sharing of ideas with Samuel Langley and flight historian Octave Chanute, who had built an extensive network within the aviation community (2002). Following their successful flight, however, the Wright's network was limited through secrecy that was driven by a desire to patent the airplane and secure a monopoly, even rejecting Chanute's request for information about their maiden flights (Shulman, 2002). The Wright's cut themselves off from their network, preferring to secure the patents rather than build upon their technological feat. The loss of their network also led to stagnation in their innovation efforts. Glenn Curtiss, on the other hand, was anything but secretive. He and the Aerial Experiment Association built his June Bug aircraft and demonstrated flying to the public. Eventually, Curtiss' collaborative network yielded the invention of 500 aviation devices, many of which are still in use today. His factory invented and sold the flying boat to the Navy along with 6,000 JN-1 Jenny's, making Curtiss Aircraft one of the largest aircraft companies in the world (Shulman, 2002). In essence, the duel between the Wright's and Curtiss proved that the success of complex projects is predicated upon the structure of the project's network of collaborators.

Would Curtiss recognize today's billion-dollar weapon system programs with their high-stakes decision-making process ensuring that entrepreneurs do not waste precious taxpayer resources? Or, has the world not changed that much…do successful programs still collaborate and network to successfully deliver capabilities to warfighters?

B. ACQUISITION PROCESS PROBLEMS

Department of Defense (DoD) weapon system acquisition programs are plagued with performance shortfalls, and even more notably, cost and schedule overruns. Addressing this problem has spawned numerous studies and reforms over many years. Most recently, the push to reinvent government in the 1990s resulted in a series of reforms that led acquisition toward a market-based model. Despite these efforts to improve efficiency, success has yet to be realized with several recent studies noting increasing cost and schedule overruns. Civilian and military officials at the highest levels in the Pentagon have expressed frustration at the lack of balance among the competing interests of cost, schedule, and performance in weapon system acquisition programs. Given many stakeholders with multiple interests in the acquisition process and the inability of high-ranking officials to achieve a balance among competing interests, assigning a program manager responsibility for balancing cost, schedule, and performance appears to be a nearly impossible task.

In addition to problems managing costs, schedule, and performance, warfighters are asking even more from their weapon systems, requiring capabilities that are joint, interoperable, and able to seamlessly share information. Joint staffs are looking to gain an advantage on the battlefield based upon a revolution in military affairs driven by the explosion in information technology. A weapon system program manager must manage not only her own baseline, but in addition rely on capabilities from other systems that are also in development.

C. ALTERNATIVES TO ACQUISITION PROBLEMS

With the many challenges of weapon system acquisition, there have been a series of changes to the acquisition process. The number of congressional committees and the volumes of the authorizations and appropriations bills have exploded, often specifying exactly how to spend the appropriated money. There have been many changes to the Federal Acquisition Regulations ensuring that contractors share information during negotiations, promoting competition, and leveraging commercial product development.

Within DoD, initiatives have included streamlining, flexibility, cooperative decision-making, and more reliance on contractor best practices.

All of these initiatives point toward three alternative ways to solve the acquisition problems: hierarchical control, market solutions, or network collaboration. Powell (1990) concluded that hierarchies, markets, and networks are the three basic forms of organization. Congressional and politically-appointed civilian control of the weapon system acquisition process makes one initially think of acquisition as a hierarchy. Indeed, the military chain of command and accountability structure within DoD makes this argument very plausible. Alternatively, weapon system acquisition relies heavily on contractors who possess the know-how and resources to produce major weapon systems. A market-based solution to acquisition problems is also rational. Networks, on the other hand, offer relationships that are built upon flexibility, thereby avoiding both the bureaucracy associated with hierarchies and the inability to internalize uncertainty associated with markets.

The policy-makers and practitioners within the weapon system acquisition process do not typically think of the process in network terms. Yet Powell (1990) concluded that networks are the predominant form of organization with a very few pure markets or hierarchies in existence. This project is devoted to describing the acquisition process in network terms. Therefore, the research question for this professional report is:

- Does the DoD weapon system acquisition process behave as a network?

The focus of this project is to understand how weapon system acquisition programs accomplish their objectives, and whether those interactions fit within the description of a network. This analysis will offer a new perspective on the acquisition process.

D. METHODOLOGY

Chapter II describes the acquisition process and its interactions with both the warfighters who describe weapon system capability needs and the budget staff who

balance alternative needs against fiscal constraints. A process model will be introduced to describe the full set of activities and interactions a program must go through from concept to delivery and operation.

With the activities of the acquisition process in mind, Chapter III highlights the characteristics of networks. A definition of networks is established and aspects of networks are described from a review of literature. Several network analysis techniques are coupled with a description of operating within networks, allowing an analysis of the acquisition process in network terms in Chapter IV.

Finally, Chapter V offers conclusions to the basic research question of whether weapon system acquisition may be described in network terms. Further, several recommendations are offered to improve this analysis and further apply a network model to acquisition.

II. WEAPON SYSTEM ACQUISITION PROCESS

The Department of Defense (DoD) weapon system acquisition process must be described before it can be characterized as a hierarchy, network, or market. This Chapter will describe the acquisition process and its interactions with other key processes. To analyze these interactions, a detailed process model will be introduced that describes the activities and actors involved in transforming inputs into outputs in the form of knowledge and, ultimately, weapon systems.

A. BACKGROUND

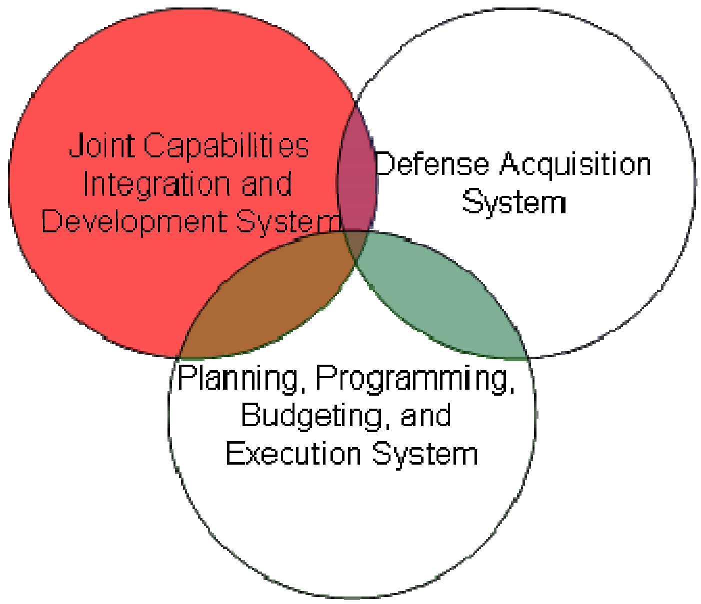
The mission of defense acquisition is to deliver needed capabilities to warfighters. In the hands of warfighters, these capabilities are able to produce constructive effects on the battlefield. The defense acquisition system is, in essence, developing the set of equipment that will be used to fight the next war. The process of competing agencies collaborating to make these decisions is a very complex task that combines optimization of doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) solutions within the Joint Capabilities and Integration Development System (JCIDS). Additionally, these decisions are dynamic, changing over time in response to environmental variables. This results in changing desires and continuing debate over what is the best solution.

Further, delivering materiel capability requires a complex set of actors, and even more stakeholders, who from markedly different perspectives seek to optimize the various processes of technology development, integration, test and evaluation, production, fielding, and sustainment of weapon systems. Nevertheless, the governing directive within the DoD gives the Program Manager the purported authority and the clear responsibility to deliver required capabilities to the warfighter (DoD Directive 5000.1: 2003). Therefore, the Program Manager must find ways to shape the capability needs from the JCIDS requirements generation system; choose a design architecture, mature technologies, and develop an acquisition strategy within the Defense Acquisition System; and seek resources from the Planning, Programming, Budgeting, and Execution

(PPBE) System. These interactions are depicted in Figure 1 below. Dynamic interaction among these systems is required to deliver a capability to the warfighter. Kadish, et al described this interaction as the "Big A" acquisition process (2006). This professional report will use this cross-cutting definition of the acquisition process.

This chapter will highlight the key processes and interactions required to deliver a capability. The JCIDS, Defense Acquisition System, and PPBE system will be briefly examined. A process model will be introduced to highlight the depth and complexity of the interactions the acquisition process must perform to deliver a capability.

Figure 1. Process Interaction To Deliver Weapon Systems (Kadish, et al, 2006)



1. Joint Capabilities Integration and Development System (JCIDS)

The Joint Capabilities Integration and Development System (JCIDS) was born out of the perception that each service parochially examined alternatives within their own core competencies, rather than from the perspective of a joint warfighting environment. The Goldwater-Nichols Act of 1986 created a framework where Combatant Commanders (COCOMs) are responsible for joint operations and service secretaries and commanders are responsible to organize, train, and equip the military to conduct army, naval, and air operations in support of the combatant commanders (Public Law 99-433). The Goldwater Nichols Act gave the COCOMs a significant voice in the funding process.

JCIDS essentially took the next step and institutionalized a process where requirements are jointly conceived, validated, and approved prior to each service implementing those needs.

The other effect of JCIDS is to define capabilities gaps rather than threat-driven needs. The Chairman, Joint Chiefs of Staff Instruction (CJCSI) defined capabilities as:

> The ability to achieve a desired effect under specified standards and conditions through combinations of means and ways to perform a set of tasks. It is defined by an operational user and expressed in broad operational terms in the format of a joint or initial capabilities document or a joint doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) change recommendation. (CJCSI 3170.01E, 2005).

a. JCIDS Process

JCIDS specifies a series of analyses that must take place to shape the capability gap into a defined set of needs in the form of a sequence of Initial Capabilities Documents (ICD), Capabilities Development Documents (CDD), and Capabilities Production Documents (CPD) that provide the overarching definition of program performance required from each defense acquisition program. JCIDS is comprised of four steps. The Functional Area Analysis (FAA) produces a set of capabilities and their tasks and attributes. The Functional Needs Analysis analyzes the capabilities from the FAA and produces a list of capabilities gaps. These results are documented in the Joint Capability Document (JCD) which the Joint Requirements Oversight Council (JROC) may review if it impacts joint warfighting. The Functional Solution Analysis takes one capability gap and reviews materiel and non-materiel solutions resulting in potential approaches to satisfy that gap. Finally, an independent team from the sponsoring command or agency reviews the results which are input into an Initial Capabilities Document (ICD) (CJCSM 3170.01B, 2005). Figure 2 depicts the analysis process.

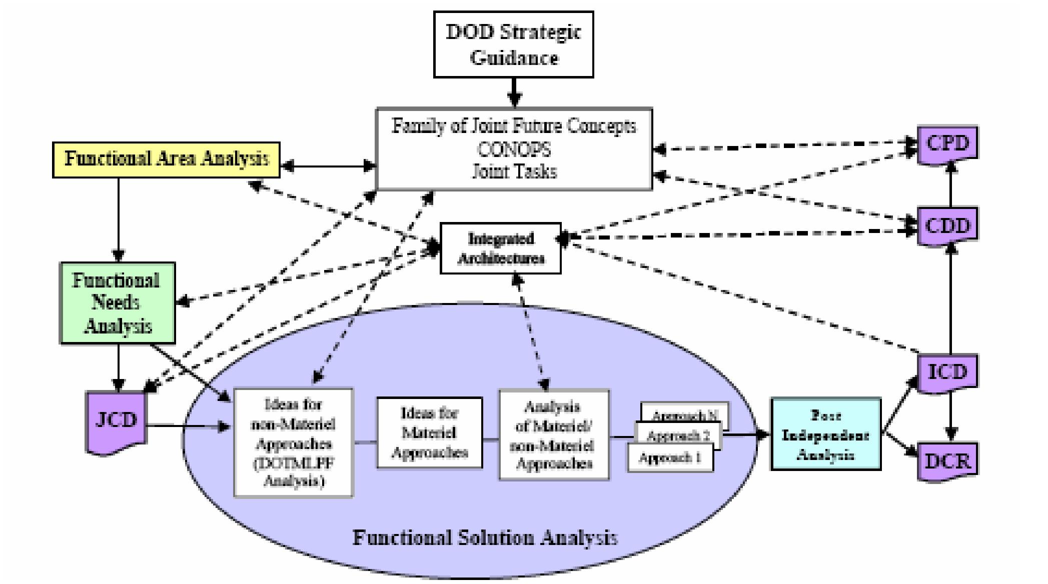
b. JCIDS Pattern of Relationships

The drivers of the JCIDS process are the representatives of the warfighting community. The Combatant Commands own the Uniformed Joint Task List which is the basis for the Functional Area Analysis. The Joint Staff oversees the process itself

initially through their eight Functional Capability Boards and then final JROC approval of the JCD and ICD. The services' requirements communities become involved as a sponsor of an approach that falls inside one of their warfighting core competencies.

One difficulty in the JCIDS process is getting the services involved without corrupting the process by making it a forum for the each service to argue for their preferred approach. JCIDS is supposed to avoid this problem through Joint Staff analysis of capability gaps identified by the Combatant Commands. Should the services be relegated to a reactive role at the end of the process as the sponsor of the requirement, the funding agency, and the developer and integrator of the acquisition program?

Figure 2. JCIDS Analysis Process (CJSCM 3170.01B, 2005: A-2)



Several presentations at the PEO/SYSCOM Conference in December 2003 outlined what are essentially opposing views on the service's role during a panel on aligning JCIDS and the Defense Acquisition System. Dr Glenn Lamartin, OSD(AT&L) Director of Defense Systems noted throughout his briefing that the new JCIDS and Acquisition policies had to be followed with collaborative relationships between OSD, the Functional Capabilities Boards, and the Services to support decision-making (2003). Dr. Nancy Spruill, OSD(AT&L) Director of Acquisition Resources and Analysis, supported a view that OSD ought to be the decision-maker in the process, holding cross-

cutting Defense Acquisition Boards and either cutting or accelerating service programs to meet joint needs (2003). Essentially, Dr Spruill viewed the services as materiel providers, who would react to OSD-defined solutions, whereas Dr Lamartin valued the services inputs to the joint architectures and decisions as a critical interdependency. The right viewpoint is the one that recognizes how information is distributed. If information that is needed for decision-making is distributed within the services and the combatant commands, the services ought to be involved. If the Combatant Commands and Joint Staff have the information they need to derive alternatives that integrate with current warfighting systems and doctrine, then the services might be viewed as implementers of systems.

c. JCIDS Realities

As structured as the JCIDS process appears, the reality is that requirements change over time. As technological possibilities and threat conditions change, so do the needs of the warfighter. Within the acquisition community, this "requirements creep" may show up late in the acquisition process in the form of expectations or actual changes to written requirements. JCIDS institutionalized this concept with the CPD, offering the opportunity for requirements changes just before entering low-rate initial production of an item (Matthews, 2004).

Further, the expectations of the warfighter are often not met in a timely manner because their expectations evolve over time. Without changing written requirements, the operational community may interpret what they previously stated in a requirements document differently over time. For example, a system is tested against measures of effectiveness that are derived from Capability Development Documents. Another set of measures define the operational suitability of a system. These allow some interpretation concerning how the system is used and employed given typical operational and maintenance personnel who help test the system during operational testing. Dynamic interpretations of these measures have occasionally resulted in systems being declared operationally effective but not operationally suitable.

2. Planning, Programming, Budgeting, and Execution System

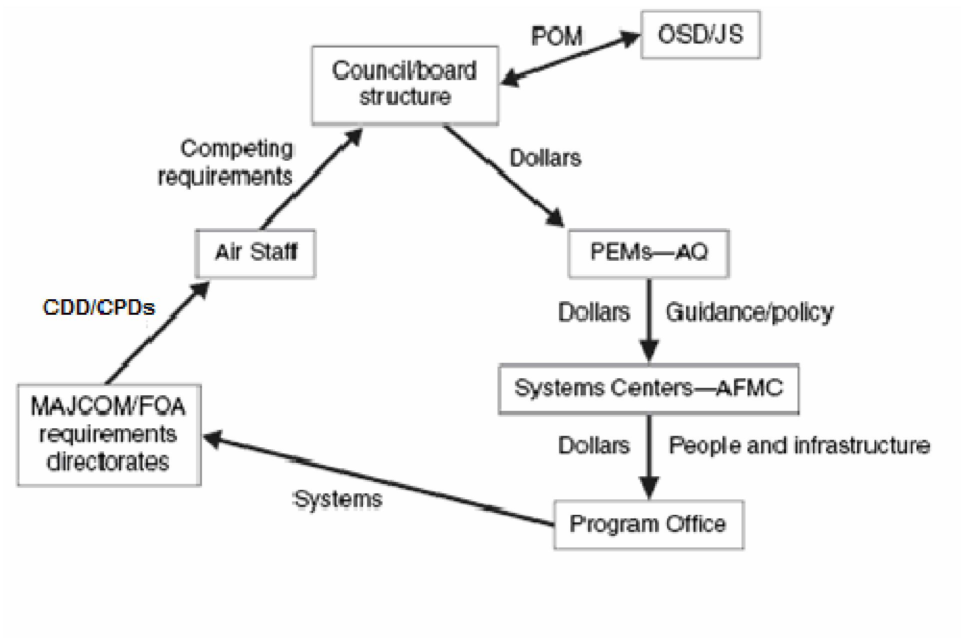
The funding for the program comes through the PPBE process. Every other year OSD issues budget guidance and the services begin a biannual cycle of preparing program objective memorandums (POM) to advocate their program's needs among other service priorities. Eventually, the OSD comptroller and the Office of Management and Budget (OMB) prepare the defense portion of the President's Budget. Even though Congress normally appropriates money for only each fiscal year, the POM for a program portrays the budget reflected in the Future Year Defense Program. This, in essence, gives the budget community a forecast of what the budget will look like to satisfy spending priorities for the next several fiscal years.

a. PPBE Function

The Planning, Programming, Budgeting, and Execution system is a centralized, structured way of allocating resources to support the National Security Strategy. McCaffrey and Jones described the goal of PPBE as balancing forces, equipment, and support given resource constraints (2004). Given the competitive nature of the services, this process allows the Secretary of Defense to balance competing objectives and select the most beneficial use of resources.

The overlap of the planning, programming, budgeting, and execution phases, along with the multitude of disparate stakeholders, makes the system very complex. Nonetheless, there is structure from the strategies of the planning phase, to the alternatives of the programming phase, the constraining of the budgeting phase, and finally, the execution phase where funds are appropriated, allocated, re-allocated, and expended. The Air Force process is shown in Figure 3. Lewis, et al. contend that the process is very much governed by modernization and basing plans since the Air Force emphasizes this portion of their budget. Additionally, the process includes centralized planning and decentralized execution with the Major Commands (MAJCOMs) playing a key role as the interface with the COCOMs (2002). Likewise, the Air Force centralized planning process interfaces with OSD and the joint staff to internalize changes in planning and other service priorities.

Figure 3. Air Force PPBE Process (Lewis, Brown, Roll, 2002: 67)



3. Defense Acquisition System

The Defense Acquisition System refines concepts; matures technologies; develops and integrates system designs; and tests, produces, sustains, and disposes of weapon systems in response to warfighter needs. The Department of Defense Directive (DODD 5000.1, 2003: 3.2) governing weapon system acquisition defines an acquisition program as: "a directed, funded effort that provides a new, improved, or continuing materiel, weapon or information system or service capability in response to an approved need."

The direction comes in the form of responsibilities spelled out in a Program Management Directive. This document spells out the high-level responsibilities of the sponsor (e.g., in the Air Force this would be a MAJCOM such as Air Combat Command), the System Program Office, and the responsible test organizations for developmental and operational test.

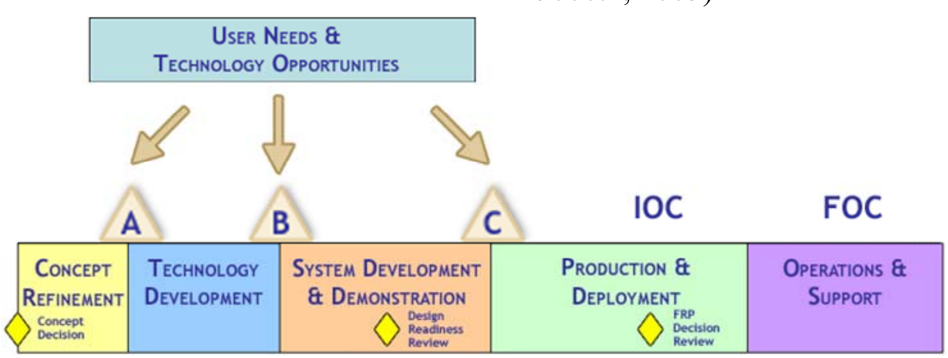
The sponsor uses the JCIDS process as outlined above to define the need. The interface with the acquisition community is through the Initial Capabilities Document. This input is refined in the concept refinement phase through the Analysis of Alternatives

process to select a materiel alternative that is cost and operationally effective. The sponsor is responsible for the analysis of alternative using a collaborative process with the acquirer, developer, tester, and other enabling communities to refine the "art of the possible" (Air Force Instruction 63-101, 2005: 9).

a. Acquisition Process

The acquisition process uses a high-level framework as shown in Figure 4 that serves as a common reference and set of expectations for all programs. The reality is that every program is unique. An infamous retort within the acquisition community when asked a general question about acquisition programs is "It depends." The particular phase where a program enters the process depends upon the level of technological maturity. The strategy to exit that phase depends on the pre-defined expectations of the milestone decision authority. This sounds simple, but who shapes the expectations of the milestone decision authority? Certainly the operational, maintenance, sustainment, test, technology, and budget community, both within the service and at higher levels can influence the milestone decision authority's expectations.

Figure 4. Acquisition Phases and Milestones (Department of Defense Instruction 5000.2, 2003)



With multiple communities influencing the acquisition process, the Milestone Decision Authority (MDA) must have some way of sorting through these perspectives to make a decision. One of the mantras of the updated DoD Directive 5000.1 (2003: 4.3.1) is to supposedly provide program managers flexibility and lift the burden of regulations. The first policy directive in the document states:

> Flexibility. There is no one best way to structure an acquisition program to accomplish the objective of the Defense Acquisition System. MDAs and PMs shall tailor program strategies and oversight, including documentation of program information, acquisition phases, the timing and scope of decision reviews, and decision levels, to fit the particular conditions of that program, consistent with applicable laws and regulations and the time-sensitivity of the capability need.

This directive appears to give managers and decision-makers the authority to develop tailored strategies based on value to the customer. This may not be true, however, given oversight from the Service and Defense Acquisition Executive combined with necessary interfaces with the contracting, financial, and test and evaluation communities, whose regulations, policies, and culture may not allow a program manager to reject activities with less customer value. The reality is weapon system acquisition process is a complex set of activities with few autonomous decision makers.

Despite many interdependencies across the acquisition stakeholder community, DoD Directive 5000.1 names the milestone decision authority and program manager as key participants. The milestone decision authority is given overall responsibility for the program, while the program manager is "the designated individual with the responsibility for and authority to meet program objectives." (2003). The reality, however, is that the program manager must collaborate among many interests to accomplish program objectives. Collaboration using integrated product teams (IPT) is the tool designated to resolve competing interests. The collaborative process is not specified in detail, although DoD Directive 5000.1 (2003) lists the communities that ought to participate in collaborative decision-making and identifies the IPT as the entry point for organizations that want to collaborate. The program manager and milestone decision authority use the IPTs' advice to make better decisions (DoD Directive 5000.1, 2003).

b. Multiple Outcomes from Many Stakeholders

The Department of Defense weapon system acquisition process has been characterized as an effective but inefficient system, which has delivered preeminent warfighting capabilities while also routinely breaching cost and schedule constraints (Augustine: 2006). The Quadrennial Defense Review (QDR) highlighted this lack of

balance demanding that the defense acquisition system along with DoD's other support systems improve agility, flexibility, and horizontal integration. The QDR lays out a vision where 1) the system is responsive to stakeholders as a steward of taxpayer dollars, 2) information and analysis are available for timely decisions, and 3) efficient business processes reduce redundancy (2006).

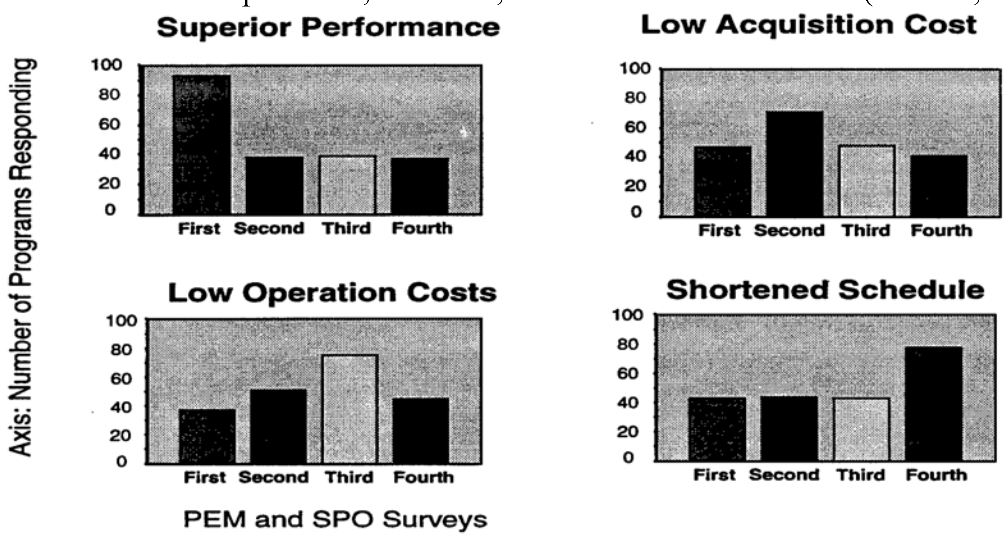
While the goals of any project are to meet customer cost, schedule, and performance goals, the acquisition system favors performance goals over cost and schedule goals. General David Jones, retired Chairman of the Joint Chiefs of Staff, advocated changes to the acquisition and requirements systems after his retirement in 1982. He was frustrated with both his lack of control and the system's resistance to change, noting that additional funding of needs is not the answer since "we get less capability than we should from our increased defense budgets" (1996: 24). Norman Augustine, CEO of Martin Marietta and Chairman of the Defense Science board in 1983, agreed with Jones, empirically concluding weapon systems meet performance goals 70% of the time, while schedule and cost goals are met 15% and 10% of the time, respectively (Augustine and Fabini, 1983).

McNutt focused on weapon system development and initial production cycle time including the causes of lengthening project schedules. He surveyed Headquarters (HQ) USAF program element monitors, finding that 80% of projects had a need date of as soon as possible, while 20% had a need date in the future. Current operational requirements gaps drove the need in 70% of programs (McNutt:1998). Yet as shown in Figure 5, the development community rated performance and cost factors higher than schedule. Correspondingly, when selecting a contractor, McNutt reported only 12% of program mangers listed product development time as a very important factor. Not surprisingly, 60% of the contractors surveyed responded that they had no incentive to propose a schedule different than the expected schedule. Likewise, program managers reported their incentive was to meet expected schedules, rather than exceed them (1998).

The list of stakeholders within the acquisition process includes a variety of organizations with different expected outcomes. The stakeholder list presupposes that

everyone in the organization supports the same outcomes. Yet, even within organizations, individuals have projects that they value more than others. A member on the House Armed Services Committee will behave differently than a member of the Senate Budget Committee. Nonetheless, this generalization of stakeholders gives some idea of the variety of outcomes desired among the various actors.

Figure 5. Developers Cost, Schedule, and Performance Priorities (McNutt, 1998: 189)



Congress

Congress plays a significant role in the acquisition process given their role in authorizing and appropriating funds for acquisition programs and overseeing those programs. Article 1, Section 8 of the US Constitution vests Congress with the authority to:

- Collect taxes to "provide for the common defence"
- "To raise and support an Army"
- "To provide and maintain a Navy"
- Govern and regulate the land and naval forces

Much of the work of Congress is done in committees, and acquisition funding and oversight work is no different. The Armed Services Committees are

considered to be the acquisition experts in Congress. They review military strategies and authorize weapon systems. The appropriations committees, on the other hand, are generalists in Congress. Although they fund specific weapon system programs, they are also concerned about other fiscal needs, such as the various entitlement programs. Finally, the budget committee is the most general of all. They apportion budget amounts through a recommended budget resolution, and are concerned about balancing the budget as a whole. Table 1 outlines the key House and Senate votes that affect acquisition programs.

Table 1. Congressional Votes on the Defense Budget (McCaffrey and Jones, 2004: 150)

Opportunities for Votes on Defense							
	Budget Resolution	Armed Services	DoD Approp.	Milcon Approp.	Dept Of Energy Approp.	DoD Suplntl	Cont. Res. Auth.
Subcommittee		H, S	H, S	H, S	H, S		
Full Committee	H, S	H, S	H, S	H, S	H, S		
Floor	H, S	H, S	H, S	H, S	H, S	H, S	H, S
Conf. Rpt. Approval	H, S	H, S	H, S	H, S	H, S	H, S	

Congress is also involved in oversight of weapons systems. Committees hear testimony on reforms to the acquisition process, on specific acquisition programs, and finally on the effectiveness of programs through an annual report from the Director of Operational Test and Evaluation. Congress exercises its authority through the authorization and appropriations process, often changing the authorized quantity or the budget amounts for any given program. They also pass laws and regulations, which govern the acquisition process such as the Federal Acquisition Regulations which specify how the Federal government contracts for all goods and services, including weapon systems.

While Congress is not unified in the goals they seek, there are some characteristics of weapons systems that are typically desired. Congress desires weapons systems that meet their early cost projections, penalizing those programs whose cost

grows 25% and therefore requires declaration of a Nunn-McCurdy cost breach. These programs must be recertified may possibly be canceled in the process. Congress also seeks effective weapon systems that demonstrate Congress' commitment to a strong national defense and to the protection of servicemen's lives. Finally, elected representatives seek to support their districts and the constituencies who voted for them by maintaining and increasing DoD acquisition-related jobs in their states and districts. Congressman will, therefore, want to understand how a weapon system is impacting their districts. They will seek possible job opportunities and funding for industry, universities, and military installations in their home districts.

Office of Secretary of Defense

The Office of Secretary of Defense is responsible to carry out the President's national military strategy. In shaping the national military strategy, OSD is involved in both laying out a vision for national defense and in selecting the weapon systems that support this vision. They author the Quadrennial Defense Review and the Budget Planning Guidance, which shapes the strategic thinking within the Pentagon. OSD also administers Program Budget Decisions (PBD) that dictate budget cuts to the services as they prepare the president's budget for the upcoming fiscal year.

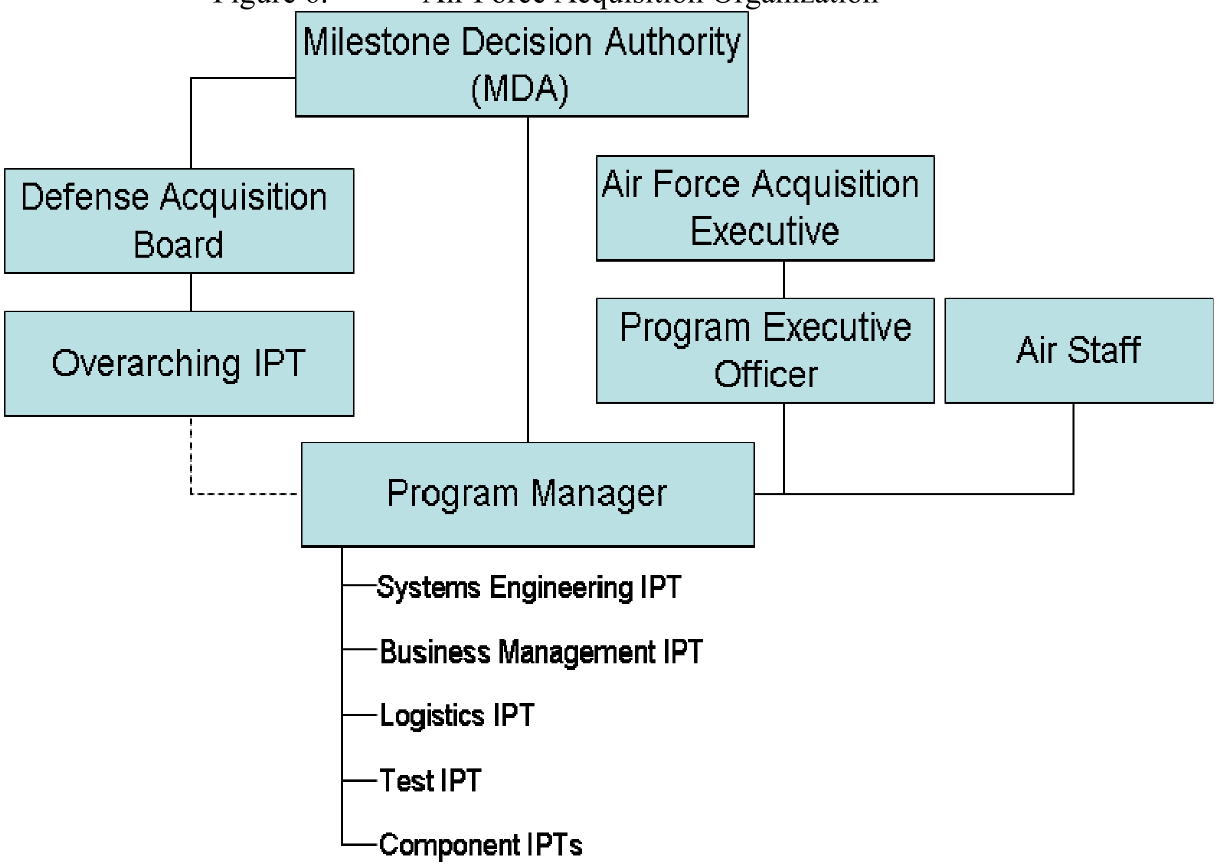
Another key stakeholder within the Office of the Secretary of Defense is the Under Secretary of Defense for Acquisition, Technology and Logistics. OSD/AT&L is specifically charged by the Secretary of Defense to carry out the modernization portion of the National Military Strategy. This office carries out these responsibilities in two ways. They are responsible for the DoD 5000 series regulations, which specify overarching policy for all acquisition programs. OSD/AT&L is also the milestone decision authority for the largest and most costly acquisition programs.

Military Services

The Army, Navy, Marine, and Air Force services all play a key role in the acquisition process. As in any hierarchy, there are specialists who oversee key pieces of the acquisition process. Each service has logistics, budget, test and evaluation, requirements/operations, science and technology, and acquisition functions. Each of

these functions plays key role in the acquisition process. In recognizing the key role each function plays, the acquisition organization has adopted the Integrated Product and Process Development (IPPD) process to collaborate and integrate the knowledge each discipline brings to the acquisition process. Figure 6 depicts a typical program office execution chain, highlighting the key roles each working-level IPT plays in advising the program manager. The program manager also gains valuable information through interfaces with the contractor, depot, laboratories, Higher Headquarters staff, and MAJCOM sponsors.

Figure 6. Air Force Acquisition Organization



What should be noted in Figure 6 is that the program manager has multiple chains of command. For oversight and milestone decisions, the program manager must go up through the Overarching IPT (OIPT) and Defense Acquisition Board (DAB) to the MDA. The DAB and OIPT, however, are composed of a host of high-level

representatives from across OSD and the joint staff, as shown in Figure 7. Day-to-day management, however, is managed through the program executive officer (PEO) and Air Staff. In fact, the PEO is the program manager's direct supervisor.

Figure 7. OIPT and DAB Members (Preston, 1996: 19)

OIPT LEADERS

DAB	MAISRC
• DASD (C3I Acquisition) • Director, Strategic & Tactical Systems • ADUSD (Space)	Director, Acquisition Oversight, ODASD (C3IA)

OIPT MEMBER OFFICES

Component Acquisition Executives

Component Representatives *
- PEO
- PM
- Operators
- Senior Information Management Official **

User *

Vice Chairman, Joint Chiefs of Staff

Under Secretary of Defense (Comptroller)

Assistant Secretary of Defense (C3I)

Director, Defense Procurement

Director, Operational Test and Evaluation

Director, Program Analysis and Evaluation

Director, Acquisition Program Integration

Director, Test, Systems Engineering & Evaluation

Chairman, OSD Cost Analysis Improvement Group (DAB only)

Director, Counterintelligence & Defense Security Programs, OASD(C3I) (DAB only)

Under Secretary of Defense (Personnel & Readiness) *

Under Secretary of Defense (Policy) *

Assistant to the Secretary of Defense (Atomic Energy) *

Assistant Secretary of Defense (Reserve Affairs) *

Deputy Under Secretary of Defense (Acquisition Reform) *

Deputy Under Secretary of Defense (Advanced Technology) *

Deputy Under Secretary of Defense (Environmental Security) *

Deputy Under Secretary of Defense (Logistics) *

Deputy General Counsel (Acquisition and Logistics) *

Deputy Director, Defense Research & Engineering *

Assistant Secretary of Defense (Economic Security) *

Assistant Secretary of Defense (Health Affairs) *

Director, Ballistic Missile Defense Organization *

Director, Defense Intelligence Agency *

Director, Defense Information Systems Agency **

Director, National Reconnaissance Office *

DASD(C3) *

DASD (Information Management) (MAISRC only) *

Director, Continuous Acquisition and Life Cycle Support (CALS) *

Director, Central Imagery Office *

Director, Special Programs *

* As required
** Always required for ACAT IAM

The interactions on the program are much more complex than is depicted in Figure 6. The Systems Engineering IPT interfaces with the sponsor command, the combatant commands, the national security agency, other systems with which the system must integrate, and finally the contractor that is developing the system. The business management IPT interfaces with the contracting community at the center-level, Air Force Material Command-level, and Air Staff-level. Likewise, the PPBE process requires the program to interface at the PEO-level and-Air Staff level with support from the sponsor command to secure funding. The logistics IPT must work with the sponsor command logistics directorate that oversees organizational level maintenance and the Air Force Material Command logistics directorate that oversees depot-level maintenance to define the maintenance and support concepts for the system.

Contractors

DoD weapon system acquisition is distinct from other types of research and development in several ways. First, DoD weapon system acquisition is a very large and complex business organization. Fox contends DoD is the most complex business organization in the world, executing more than 60,000 contracts per day (1988). While many businesses share complex interactions, Fox and Gansler point out key differences between DoD weapons acquisition and commercial enterprises. Fox notes that in most industries, management is free to make decisions about strategies (e.g. product, production, quantity, distribution) being bound by a desire for profits. Whereas in DoD, the government decides on the features of the product and the quantity, suppliers propose designs and promises of performance, and the supplier often holds a monopoly (1988). Gansler compares defense to either a regulated or planned economy. Most regulated industries are regulated on the supply side, whereas DoD is regulated on the demand side. Also, DoD bears some resemblance to a planned economy where needs are dictated and the government owns facilities (1989). Fox (1988) notes that DoD, unlike commercial enterprises, has always relied on industry to deliver needed technology and material and rarely owns and operates production facilities. Given these differences, models empirically applied to private industry may not achieve the same results applied to the

DoD weapon system processes. The unique nature of weapon systems requires models and empirical studies using DoD samples that account for the complexity and unique aspects of weapon system acquisition.

Of course, contractors who support weapon system acquisition are still business entities and operate using business models that are modified for the monopsonistic, regulated weapon system acquisition environment. The contractors are motivated for profits, return on investment, cash flow, market share, and future business. The difference in the weapon system acquisition environment is that the government dictates requirements and also bears most of the research and development cost to mature technologies and designs. On the flip side, the government regulates the amount of profit that may be charged and attempts to ensure symmetric information through the Truth in Negotiations Act and cost accounting standards.

c. Stakeholder Management

Uncertainty during long acquisition development cycles and differing values within an organization the size of the DoD, leads to conflicts associated with the content and processes of an acquisition program. The multitudes of organizations listed in Figure 10 have different agendas and bounded rationality. How is the program manager to manage this conflict? Colleen Preston in the OSD/AT&L Overarching IPT/ Working-level IPT (WIPT) Information Guide, depicted the issue resolution process as shown in Figure 8, where a program manager must elevate an issue to general officer-level and even up to Component Acquisition Executive (CAE) or Defense Acquisition Executive (DAE) to resolve conflicts (1996). The reality is that the program manager is better off managing issues at a much lower level before elevating them and spending the energy to resolve them among general officers and their staffs.

To proactively address conflicts before they become issues, program managers may use an informal stakeholder management process. Most managers might call this a risk management process, wherein they recognize the probability that an issue might impact cost, schedule, or performance. Also, the program manager assesses the consequence of that issue transpiring. Walking into a room full of high-level decision-

makers without recognizing the issues that impact the program and who is driving those issues does not bode well for a program. Rather, most program managers would avoid conflicts involving general officers. Bryson (2004) suggested that public managers proactively formulated issues and organized coalitions to strategically resolve those issues, eventually resulting in redefinitions of organizations. This does not suggest that issues will not come up as a program is going through a major decision review. The reality, however, is that programs only go through major decisions every few years, and probably use a process similar to Figure 9 on a more routine basis.

Figure 8. IPT Issue Resolution Process (Preston, 1996: 20)

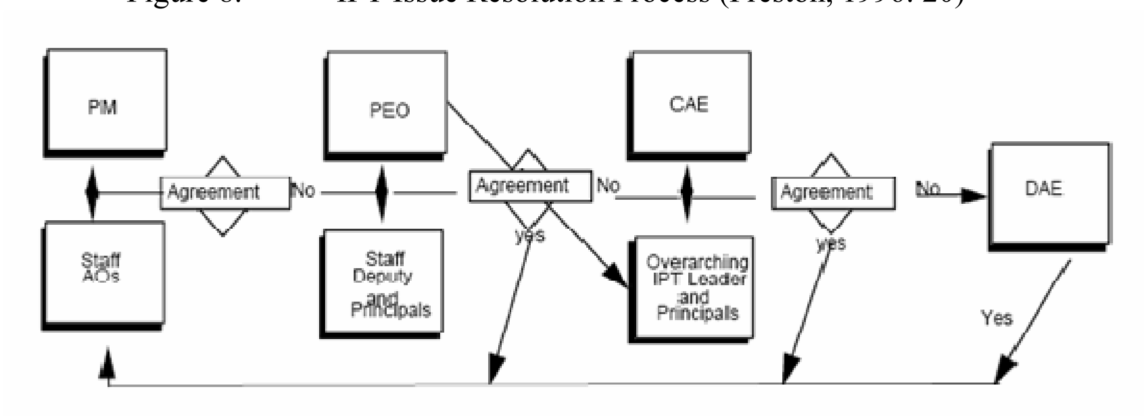
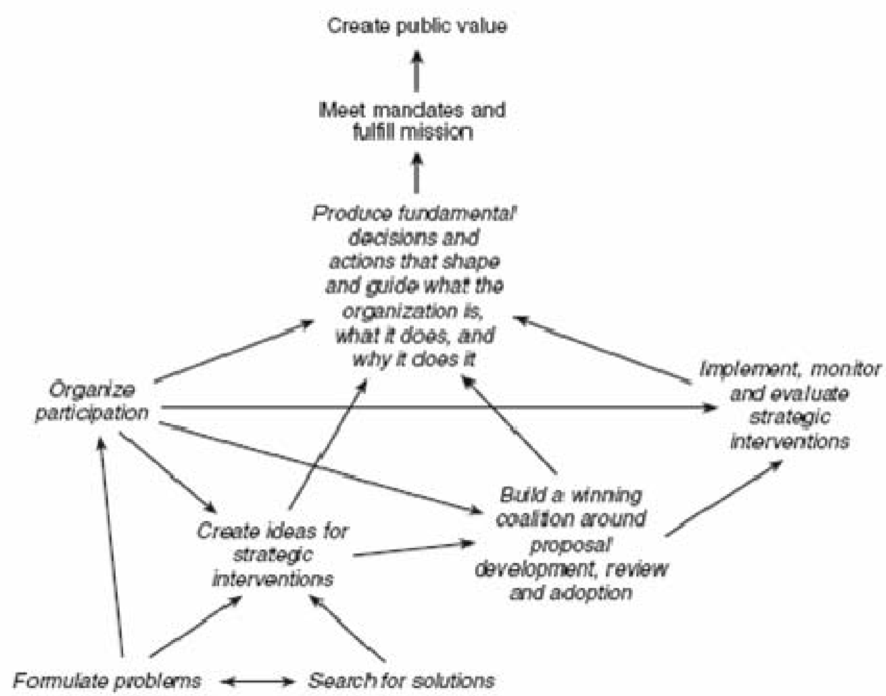


Figure 9. Program Stakeholder Analysis (Bryson, 2004: 25)



Stakeholders' interactions, however, should be reviewed in a strategic context, since they may impact or be impacted by the program. One of the four major findings of the Defense Science Board study on cost growth in space programs was that the government capability to manage programs had seriously eroded. This erosion was partially due to program manager's inability to manage an expanding set of stakeholder needs on their programs, resulting in more requirements than the funding constraints on the program would allow (Young, 2003).

B. WEAPON SYSTEM ACQUISITION PROCESS MODEL

1. Purpose

Given a plethora of the stakeholders and a complex product development process, the set of interactions required to manage a program need to be well understood. Describing the process to manage an acquisition program helps assess who interacts and how they interact to accomplish a program. The Assistant Secretary of the Air Force (Acquisition Integration), SAF/AQX, formed the Acquisition Process Action Team (APAT) in Spring 2005 to describe the set of processes Air Force weapon systems were using to accomplish their missions. The goals were to baseline the acquisition processes and form a common language and basis of measurement across the stakeholders in the

acquisition process. The group focused mainly on the defense acquisition system itself and its interactions with JCIDS and PPBE.

Lt. Col. Michael Paul and Major Ryan Mantz, SAF/AQXA, led the APAT effort. A group of consultants from the Center for Reengineering and Enabling Technologies (CRET) provided the methodology and manpower to support the data gathering effort. Mr. Mike Wilhelm, CRET, was instrumental in managing the effort.

In order to assess the interactions within weapon system acquisition, the APAT used an enterprise process model approach. A process model offers a look across the many disciplines within weapon system acquisition to understand what behaviors the team is using to solve the problem. The model is put into process terms, where each step is defined as a verb-subject relationship. Instead of describing a contracting/source selection process, the step is simply "Select Source." This allows the team to focus on the stakeholders' inputs to the process instead of driving the description solely in contracting terms.

Another important aspect of a process model is to describe the relationship between the steps and other actors. In essence, the process model is a look at the interdependencies within the acquisition system. Each step in the process is described in terms of inputs, outputs, triggers, and mechanisms. A source of those characteristics is also described. This allows the model to describe interaction with other steps in the process.

2. Data Gathering

The APAT team used the DoD 5000 series regulations as a jumping-off point. The major steps in the process were chosen as the high-level steps in the process. This allowed the model to refer back to a reference to which acquisition, logistics, finance, contracting, test, and requirements personnel could relate. Beginning with the high-level process, the APAT team held several workshops with a core group to decompose the high-level process into a series of lower-level process steps. To ensure that the process model reflected the interactions across the Air Force acquisition process, the team set up

a series of workshops with acquisition personnel to refine the second-level of the model and develop the third and lower-levels of the model. Each workshop lasted approximately two days and was focused on a particular phase of the acquisition process. The host base was selected from among those bases that focus on a particular phase. For example, Warner-Robbins Air Force Base (AFB) was chosen as the host for the Operations and Support phase workshop, since they were heavily involved in depot-level maintenance. Participants from all bases were invited, but the main, working-level participants were from the host base. A series of workshops were held at the Pentagon, Eglin AFB, Warner-Robins AFB, and Wright-Patterson AFB. Further, telephone conferences were held to refine the results.

The robustness of the model comes from agreement among numerous individuals from different organizations and backgrounds that the set of steps described in the model were congruent with how they did business. Over 120 people participated in the development of the model. They came from Headquarters Air Force acquisition, logistics, and operations organizations. Air Force Material Command, requirements, transformation, logistics, and engineering were also represented. All four Air Force system centers are represented, along with all three depots. Finally, Air Force Research Lab and Air Force Operational Test and Evaluation Center, along with the test wing at Eglin AFB had participants present.

3. Results

a. Overall

The team used the following definitions as part of process decomposition effort, which match closely with the DoD Architecture Framework methods of describing functions:

- **Process** – Logical set of steps transforming an input into an output
- **Inputs** – Information or resource consumed in the activity to create the output
- **Outputs** – Information produced by an activity
- **Suppliers** – Who provides the input to the process?
- **Customers** – Who receives the output of the process?

- **Key Players** – Who is ultimately responsible for the process being accomplished?
- **Controls** – Business rules that govern the performance of an activity
- **Mechanisms** – Resource that performs or supports an activity, but not consumed by the activity

Unfortunately, there was not consensus agreement on all these parameters for every process. The main focus was the process, inputs, and outputs. Once the process was defined, an attempt was made to understand supplier, customer, key player, controls, and mechanisms data.

Processes were decomposed into roughly five to seven sub-processes that were the key components of the higher-level process. The workshop participants were instructed to keep decomposing processes until they were defined at an "actionable level." In reality, the processes were decomposed until workshop participants could not agree on sub-processes that generally fit most programs.

Appendix A depicts the output from the APAT effort. There are five major processes as defined from the DoD 5000 series acquisition phases. The APAT effort identified 27 process steps supporting those major processes. Beneath the major processes are 107 sub-processes with 172 supporting activities. The workshop participants were more comfortable with the latter three phases of the acquisition process, rather than the first two. Concept Refinement and Technology Development lacked as many sub-process and supporting activity steps upon which participants were able to agree.

Even more important than the numbers of steps are the key players, suppliers, and customers of each process step. To make the data more manageable for this report, key sub processes and supporting activities were chosen from those occurring in the Concept Refinement, Technology Development, and System Design and Development phases of the acquisition process. While it was noted earlier that Concept Refinement and Technology Development were not as well-defined, these phases shape the definitions of the program and lock-in the design characteristics that affect cost

schedule and performance during the latter phases. Therefore, this report focuses on these early phases of acquisition, where the characteristics of the weapon system are largely defined.

b. Concept Refinement

This phase marks the beginning of an acquisition effort. Initial cadres of acquisition and requirements personnel begin to evaluate alternatives and define courses of action. Based on these efforts, the acquisition lead identifies key technologies and acquisition strategies to begin to prepare for later acquisition phases.

Table 2. Concept Refinement Actors

MAJCOM Requirements	(10) Industry	(18) Center Contracting (PK)
(3) AFMC	(11) Defense Intelligence Agency	(19) Acquisition Center of Excellence
(4) Lead Acquisition Organization	(12) Combatant Commanders (COCOM)	(20) AFMC/DO
(5) Milestone Decision Authority (MDA)	(13) MAJCOM Budget	(21) AF/TE
(6) Federally Funded Research and Development Centers	(14) SAF/AQ	(22) DOT&E
(7) Other Service Programs	(15) SAF/FM	(23) OSD
(8) Joint Programs	(16) AF/XP	(24) AF
(9) Allied Programs	(17) Air Force Research Lab	(25) Joint Staff

While this phase begins to explore acquisition strategies, the effort is not yet declared a program and does not have large funding associated with it. Therefore, this phase is marked by heavy involvement between the MAJCOM sponsor and the acquisition lead. Other key stakeholders, such as the Office of Secretary of Defense and Congress, may be peripherally involved at this point. Similar programs within the service, joint, or allied community may view the program as either a complement or a threat to their programs. Further, the budget, contracting, requirements, and test functions within the sponsoring MAJCOM and the acquisition community begin to get involved at this point. The table below identifies the key players involved in the Concept Refinement phase. The organizations named in Table 2 are either specified from the processes in Appendix A or implied based on documents needed for a Milestone A decision.

c. Technology Development

The purpose of the Technology Development phase is to sufficiently mature technologies so that they are able to be integrated into a system during the next phase of the acquisition process. As one would expect, this phase is marked by heavy involvement with the research laboratory and industry communities. Process 2.1.2, Identify Technologies for Maturation, and process 2.1.3, Define Technology Maturation Plan, describe the key interactions and processes required to plan the events of this phase of the acquisition life cycle.

Table 3. Technology Development Planning/Milestone Actors

MAJCOM Requirements	MAJCOM Logistics	OSD/AT&L
Lead Acquisition Organization	AFMC Logistics	Industry
MDA	SAF/AQX	Defense Advanced Research Projects Agency
AFMC/DO	Center PK	Government Laboratories

AF/TE	DIA	AF/XP
DOT&E	MAJCOM FM	SAF/FM
PEO	SAF/AQ	DAB/OIPT members (see Figure 7)
OSD/NII	COCOM	

For the purposes of this study, this phase was also chosen because Milestone B, which marks the exit of the Technology Development phase, is the first time that an acquisition effort must be declared a program. Therefore, the other purpose of Technology Development is to build support for the acquisition program, so that it may go through a successful Milestone B decision. The APAT effort described some of the key interactions that buildup to this decision point. These interactions are depicted in Process 2.5 within Appendix A.

The actors in the technology development phase are diverse, since they include those supporting specific technology efforts, as well as those evolving the requirements and readying the program for System Development and Demonstration. The actors performing technology work are joined through the lead acquisition organization to the requirements and oversight actors who are structuring the program as noted in Table 3.

d. System Development and Demonstration

An acquisition program in the System Development and Demonstration phase exhibits many interactions with oversight agencies, sponsoring commands, test, logistics, contracting, and engineering communities. The program is now spending large amounts of research and development dollars and is moving towards requests for even larger amounts of procurement funds. Stakeholders will mark the success or failure of a program at this point. Certainly, the program manager manages interdependencies with other programs, resource providers, and decision-makers as shown in process 3.1 of Appendix A.

Another key process during this phase is to develop the detailed design as shown in process 3.2.3 in Appendix A. This process involves highly-complex technical work, where the requirements that are allocated to the various portions of the system that must be integrated into a design. The working level IPTs gain in-depth insight into contractor and subcontractor performance that the program manager must ensure is shared across working-level IPTs and incorporated into higher-level acquisition planning documents and interfaces. The actors involved in these activities are noted in Table 4.

Table 4. System Development and Demonstration Management/Design Actors

MAJCOM Requirements	MAJCOM Logistics	OSD/AT&L
System Program Office	AFMC Logistics	Contractor
MDA	SAF/AQX	Subcontractor
Test Ranges	Center PK	Vendors
Air Force Operational Test and Evaluation Center	Defense Contract Management Agency	AF/XP
OSD (Comptroller)	Congress	SAF/FM
PEO	SAF/AQ	MAJCOM FM
COCOM	Center FM	Center Civil Engineering
Center Human Resources		

III. WHAT IS A NETWORK?

A. INTRODUCTION

Chapter II defines both how weapon system acquisition purportedly and actually behaves. There is a defined, hierarchical chain of command with a Milestone Decision Authority and a program manager who is responsible for delivering a weapon system capability. The APAT process study also revealed that the inputs required to deliver this capability require a set of stakeholder interactions that go outside the boundaries of the traditional chain of command. Further, the stakeholders involved have differing and dynamic objectives causing both real and perceived instability within the acquisition process. To address the question whether the defense acquisition system can be characterized as a network, one must first define networks and understand their basic properties.

1. Markets, Hierarchies, and Networks

The specialized support required for a project often conjures up images of hierarchical organizations that integrate these specialties together for a common purpose. Alternatively, a project might be accomplished through the marketplace where products and services are efficiently offered to those who have the highest willingness to pay. Ronald Coase's early work on transaction costs compared firms and markets as alternatives to one another. A firm integrated and organized resources when it was less costly compared with individual contracts in a market. Coase theorized that the monopoly power gained and the decreased costs would encourage growth of firms. Yet, he noted not everything was vertically integrated inside the firm. The growth of the firm was balanced with the increasing expenses to organize a larger labor force due to diminishing marginal returns. Eventually, the cost of an additional transaction within the firm was equal to the cost of contracting in the marketplace for the same goods or services (Coase, 1937).

In addition to Coase's description of why a marketplace and firm both exist, further refinements are necessary to understand the limits of markets and hierarchies.

Using a transaction cost framework, Williamson focused on the limitations that drive transactions out of the marketplace and the factors that limit the size of hierarchies. Markets are not efficient due to two factors: limited abilities of the actor to process information (bounded rationality) and opportunism. Transaction costs are essentially the factors which drive bounded rationality and opportunism. Uncertainty or risk; lack of competition; and informational impacts due to incomplete information are the factors which drive transactions out of the marketplace in into hierarchical, vertically-integrated organizations (Williamson 1973). On the other hand, the benefits of hierarchies over markets are limited due to coordination problems within the firm. Williamson (1967) postulated that the coordination problem grows as the firm expands for two reasons: the decision-maker is further removed from production workers and the breadth of information expands as new activities are added. Certainly, Williamson and Coase laid out a workable framework to consider whether firms or markets are more efficient at carrying out production. It is important to note that neither author considers markets and hierarchies in a continuum. While Williamson (1973), briefly mentions peer groups, he largely dismissed this organization due to limitations from free-riders who do not contribute equally to the rest of the parties. The transactional cost literature firmly described the factors that will shift production or services from a simple market to hierarchical forms of governance. Yet, it failed to fully account for all of the other forms of governance that may exist between the market and the hierarchy.

Powell introduced the concept that a network existed between a self-forming marketplace and a hierarchical organization. He rejected the view that networks are neither part of a market-to-hierarchy continuum, nor do they represent a hybrid form of hierarchy. As evidence, Powell offered two examples that pointed to the existence of networks. He noted the blurring of the boundaries between markets and inter-organizational collaborations, such at cooperative joint ventures. The second example is the creation of enduring relationships between hierarchies and their consulting, law, and banking firms indicating that a network form of governance existed between these organizations (1990).

2. Review of Network Theory

The literature offers the three parallel schools of thought on networks: sociology developed social network theory, political science formed policy networks constructs, and public administration conceived public management networks (Berry, Brower, Choi, Goa, et al., 2004). This chapter will synthesize definitions from all three disciplines as they apply to the research questions outlined in Chapter I. Specifically, this literature review seeks to focus on the defining networks and their structure. Also, the purpose of networks will be explored and compared with hierarchies and markets. Finally, the literature on project networks will be examined to determine the key characteristics of this type of network as a framework in later chapters to examine the structure and behavior of weapon systems acquisition.

B. DEFINING NETWORKS

1. Why Network?

Before delving into the definitions of a network, it is worth noting the inherent strengths and weaknesses each form of organization. Markets are ideal for simple transactions where inputs and outputs are measurable and are not based on a number of contingencies. Coase (1937: 287) described the marketplace as: "under no central control…supply is adjusted to demand, and production to consumption." If an individual needs bread, he goes to the bakery and purchases it, exchanging money for ownership of the commodity. If a community needs bread, a bakery must estimate how much bread the community will need. Built into the price of each loaf is a measure of overhead that may contain some write-offs for the wasted bread that was not purchased due to variations in demand. The market is still able to handle this degree of uncertainty through adjustments to supply and internalizing costs associated with uncertainty of demand within the price of the product.

Hierarchies evolved to control the specialized inputs needed to produce complex products or services where the inputs may not be available in the commercial marketplace. Coase (1937) used the classic example of specialized labor where a firm chose to employ an individual with specific skills rather than purchasing this person's

skills in a spot market where a price mechanism would ensure that person is used in the most beneficial manner. This allows hierarchical firms to internalize the uncertainties associated with inputs. Further, Williamson noted the inherent accountability associated with hierarchies. A supervisor would be able to not only assess an employee's potential in advance and set a wage, but observe that persons work on the job and make adjustments (1973). Therefore, hierarchies excel when inputs have uncertainty, since they allow internal observation and adjustment during the course of business.

Networks are adept at handling uncertainty associated with both inputs and outputs. O'Toole (1997) described this as wicked problems that cannot be divided into tasks that are isolated from each other. Powell agreed that networks form as organizations choose to pool resources to manage uncertainties, thereby creating interdependencies from which a firm cannot easily walk away. He elaborated that networks are particularly adept at exchanging resources that are difficult to measure, such as "know-how, technological capability, a particular approach or style of production."(1990: 304)

2. Network Definition

While a network is fairly well understood in today's society, the familiarity with networks may lead to a variety of definitions. Several definitions from social networks, public policy networks, and organizational networks will be examined. The examination will allow a common definition of a network. These definitions will allow a further examination of how networks are structured and what their purpose is.

The most straight forward definition of a network comes from sociology. Borgatti and Foster (2003: 992) described this type of governance as, "A network is a set of actors connected by a set of ties." A network may be two or more actors, but a network is different than a crowd of people walking down a street who have no interaction or ties with one another. Marsden and Lin (1982) and Knoke and Kuklinski (1991) emphasized persistent relationships among actors, focusing on their relationships rather than the actors themselves or the groups to which they belong. Whereas an actor

continues to exist apart from the network, a network does not exist without the relationship between the actors. Figure 10 depicts a simple network consisting of two actors with some defined relationship.

Figure 10. Simple Dyadic Network

While the actors may have attributes (tall, wealthy, Latino, government defense contractor, etc), they will retain these attributes whether or not they remain within the network. Knoke and Kuklinski concluded that the actor's attributes are the context within which the actors define their relationship with other actors to form the network. They surveyed the literature to understand the types of relationships studied in network analysis as shown in Table 5 (1999).

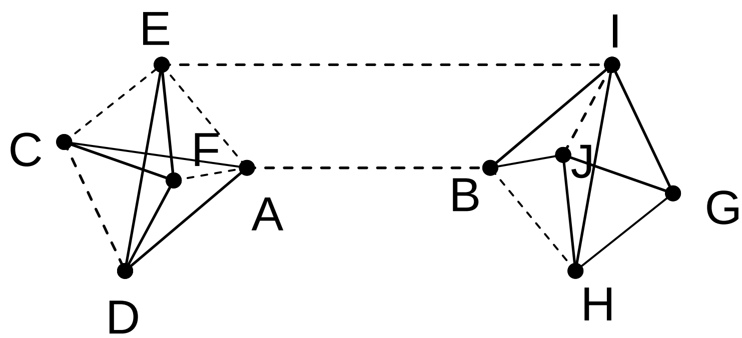
Table 5. Types of Network Relationships (Knoke and Kuklinski, 1991)

Type of Relationship	Content of Relationship
Transaction relations	Exchanges to control assets or media
Communication relations	Information sharing
Boundary penetration relations	Common constituents
Instrumental relations	Contact other actors to seek sources for goods, services, or information
Sentiment relations	Seek others to express feelings
Authority/power relations	Right and authority to command
Kinship/descent relations	Role of family members

Another key part of aspect of a network is structure. While an actor may have some type of relationship with others, Granovetter realized that networks are not centered on one actor but include influences from the relationships of the other actors. He theorized that within a network there were strong and weak ties, depending on the time, energy, and trust in the relationship. As depicted in Figure 11, if actor A has a strong tie with actor D, actor D's other strong ties will automatically be weak ties with actor A (e.g.

Actor E and Actor F's relationship with Actor A). Granovetter's realized that the weak ties were actually the bridges of information, bringing new and innovative information from disparate parts of the network (1973).

Figure 11. Network of Strong and Weak Ties (Granovetter,1973)



Another example of networks comes from the field of public administration where networks are used among government, non-government, and private agencies. Kickert, Klijn, and Koppenjan (1997: 6) described networks as "stable patterns of social relations between interdependent actors, which take shape around policy problems and/or policy programmes." This definition is broad, spanning coalitions of intergovernmental and non-governmental actors organized around both issues and delivery of public goods and services. Mandell (1988) defined a network as "linking of a diverse number of organizations and/or individuals into a purposive whole." Her definition is useful for public administration since this field looks to provide a public good from which communities benefit and that individuals may enjoy without a clear means of measuring their demand for the good. A network in this context may be a public, non-governmental, and private partnership that is focused on providing some public good or service.

One difficulty that arises is that Mandell (1988) and O'Toole (1997) added to their definitions a qualification that organizations that make up the network must be independent, even going as far as suggesting that the organizations must be legally distinct or from different levels of government. This stems from their attempt to define networks separately from hierarchies. They failed to recognize that large organizations are not issue or product-specific. Actors within the organization may value outcomes differently or perceive the risk associated with processes in a variety of ways. Kickert, et

al. (1997) viewed that networks are an extension of the limitations of single decision-makers due to bounded rationality and the process approach where many decision-makers, both within and outside the hierarchy, seek solutions for their problems.

Before choosing one definition over the others, a review of their similar characteristics reveals that all the definitions explicitly or implicitly allow two or more actors with a focus on the relationships between the actors. Sociology delves into the purpose, strength, and structure of the network. These social networks can cover many types of relationships, allowing use of their definitions and research among the many purposes of social networks. The examples of networks in policy and public administration often include long-term programs and, therefore, contain permanent, lasting relationships. This report will utilize the Kickert, et al. (1997) definition of networks where actors are dependent upon one another; there are lasting, stable relationships; and the network is formed around a policy or project. In comparing this definition with others, Klijn (1997) identified three characteristics of networks:

- Networks form due to interdependencies between actors.
- Networks consist of multiple actors who have their own objectives.
- Networks consist of the lasting relationships between the various actors.

The first condition for a network is interdependencies. Klijn (1997) suggested resource dependency is a key driver of lasting relationships since organizations set goals which require exchange of capital, personnel, and knowledge with other organizations. Further, he pointed out that dependencies are dynamic in a network, so they were difficult to classify. Powell (1990) and Jones, Hesterly, and Borgatti (1997) similarly emphasized actors within networks performing complex exchanges and transactions using trust and norms rather than simple, market-driven, legally-enforceable contracts.

Again, the condition for more than one actor comes into the definition with the added criteria that each has their own objectives. Scharpf (1978) concluded that within government there is no single actor and no unifying goal. Instead, policy was a result of interactions among multiple actors where coordination is achieved through exchanges of material, information, and legitimacy.

The final characteristic of networks is that they are composed of lasting relationships among the actors. Klijn (1997) and Jones, et al. (1997) concluded that relationship patterns in a network are defined according to their frequency over time. Repeated interactions strengthen the relationship. As a pattern of behavior develops during on-going interactions, actors will begin to understand who they can trust and who they cannot trust. Therefore, the basis for the network is the willingness to establish interdependency based on that frequent, lasting relationship.

C. NETWORK ANALYSIS

1. Introduction

Is managing within a network the same as managing in a market or hierarchy? Intuitively, the answer is no. A purely market transaction relies on the same information between buyer and seller to carry out simple transactions. Management in markets consists of ways to build knowledge of the opportunities in the marketplace or to speed transactions. Management in hierarchies consists of breaking down tasks and applying specialized skills to those tasks. Management in networks, with their lasting relationships and lack of centralized control, requires a different set of skills to gather information and apply resources to solve a problem.

Armed with a definition of a network, the next challenge is to understand how to operate in a network setting. An understanding of the network itself must preface any attempt to develop a strategy to achieve objectives in a network setting. Understanding the boundaries of the network, the power structure based on relationships, and the persistence of networks are all critical to derive some a strategy for operations within a network setting.

2. Network Boundaries

The first task is to understand the unit of analysis within a network. Aldrich (1982) concluded that a network ought to be the level of analysis, since transactions cannot be viewed as simple transactions between two parties. Transactions must be viewed from the perspective of the network as a whole. The boundary conditions, therefore, become an important characteristic of how the network operates.

A network implies exclusivity where members of the network are choosing to deal with one another rather than those beyond the network. Aldrich turned to transaction cost economics to determine the boundaries. Transaction cost economics dictate that infrequent transactions would drive actors to make few transaction-specific investments, whereas a network consists of actors making frequent transactions using transaction specific investments (1982).

This explanation ties in nicely with the Kickert, et al. (1997) definition of networks where interdependent actors have lasting relationships formed around a policy or project. Actors who are within the network and interacting frequently with one another would make transaction-specific investments thus strengthening their interdependency on one another within the network. Wal-Mart's supply chain management techniques with its supplier network provide an illustration of interdependency based on transaction-specific investment. Wal-Mart's strategy to offer low-cost, brand-name products is based not upon procuring the cheapest products. Instead, Wal-Mart works closely with its suppliers to reduce the transaction cost in the supply chain. Who is in Wal-Mart's network? Those suppliers willing to make specific investments in information technologies such as electronic data interchange and pallets with radio frequency identification devices that helps both Wal-Mart and their suppliers jointly manage their overall supply chain efficiently (Zimmerman, 2003).

3. Network Structure

In analyzing a network, the individuals within the network are not as important as the relationships between the actors within the network. Since networks imply interactions where no one individual has all the resources to solve a problem, the dyadic relationship is the basic unit of structure. At the next higher level of analysis, the network as a whole will determine the success of outcomes. How the dyadic relationships are arranged to form a network count in achieving a result. Therefore, structure determines how the group as a whole will perform.

The relationships themselves within the network could be characterized as strong or weak. Granovetter (1973) introduced this concept with his strength of weak ties theory. Measures of the strength of the tie include information capacity of the tie, rate of

information flow, probability of transmitting information, and frequency of interaction (Borgatti, 2002). As the network scales up adding more actors, the average distance between the actors may increase. Distance is measured as the minimum number of links through various nodes to connect two actors in a network (Knoke, 1990).

While strong and weak ties help to characterize the reality that not all ties are equal, another measure might be the diversity of information received from the tie. Burt (1983) introduced the concept of range to measure the diversity of actors and information within a network. Using a ego network, Burt explained that there are four measures of range: 1) the number of relationships for any given actor, 2) the number of status groups (occupation, age, sex, etc) in contact with the actor, 3) the weakness of ties with very dense, non-diverse status groups, and 4) the weakness of ties with actors who have strong ties with others in ego's network. Basically, to enhance the quality of their contacts, an actor would like to have relationships with many actors from different social groups.

The connectivity of the network as a whole may be measured various ways. A component is the portion of a network where nodes can reach every other node using some path (Borgatti, 2002). A network that is completely connected has one component, whereas one that has disconnections will contain more than one component. This fragmentation of a network implies that the network will not share resources completely across the network.

How many dyadic relationships exist within the network is another important concept describing connections within the network. Of course, the number of relationships is an absolute measure and depends on the number of actors within the network. The accepted measure within the social network analysis community is network density. Knoke (1990) defined density as the number of actual links in a network divided by the number of possible ties between nodes. The following equation defines density:

Density = $T / N(N-1)$

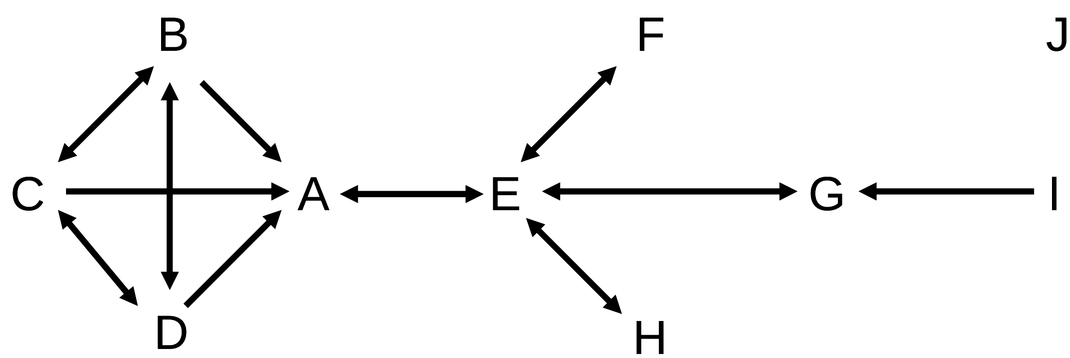
where T is actual number of ties and N is the number of nodes

For a 15-actor network where there are two-way or directed ties, the number of possible ties is 210. If there are 40 ties in the network, the density of the network is 0.19.

Density is also useful to assess subgroups within a network. Portions of the network where actors are connected to every other actor are defined as cliques, whereas social circles may have less frequency or bi-directional contact (Knoke and Kuklinski, 1991). Therefore, a subgroup with a density close to 1.0 is a clique. The strength of the ties and number of communication channels implies that this clique will completely share information.

To illustrate the concepts of measuring information flow in a network, a hypothetical example of a network where actors exchange information asymmetrically is shown in Figure 12 below:

Figure 12. Asymmetric Informational Network (Knoke, 1990: 237)



The arrows depict the flow of information, some of which is bi-directional, while several actors receive information but do not transmit information back to the other actor in the dyad. An adjacency matrix is used to represent this information flow from actors to one another. The number one in a row represents transmitting information from the actor in the row to the actor in the column, whereas a zero indicates that no information is transmitted. The number one in a column represents receipt of information, and, of course, a zero represents no information receipt. Knoke (1990) developed the following matrix in Table 6, concluding from the totals for the columns and rows that A receives the information from more sources, and E transmits information to the most actors.

Table 6. Matrix Representation of an Asymmetric Network (Knoke, 1990: 237)

	A	B	C	D	E	F	G	H	I	J	Total
A		0	0	0	1	0	0	0	0	0	1
B	1		1	1	0	0	0	0	0	0	3
C	1	1		1	0	0	0	0	0	0	3
D	1	1	1		0	0	0	0	0	0	3
E	1	0	0	0		1	1	1	0	0	4
F	0	0	0	0	1		0	0	0	0	1
G	0	0	0	0	1	0		0	0	0	1
H	0	0	0	0	1	0	0		0	0	1
I	0	0	0	0	0	0	1	0		0	1
J	0	0	0	0	0	0	0	0	0		0
Total	4	2	2	2	4	1	2	1	0	0	18

4. Actors' Positions within the Network

Switching from the network back to the individual actor as a unit of analysis, the above tools also allow an assessment of how the actor fits into the structure of the network. Since structure matters in carrying out the purpose of the network and some positions in the network receive and transmit more information than others, what conclusions may be drawn from these observations?

First, measures of actor's positions in the network will help to infer a power structure based on the structural relationships. Freeman (1977) introduced measures of a node's centrality based on his definition of position centrality: "the degree they stand between others, and can therefore facilitate, impede or bias the transmission of messages." These nodes control the information flow in the network more than others.

The measures for centrality were based on examining the probability a given point is a path of communication given all the possible points between all the possible dyads within a network, the relative measure of centrality comparing a point to all other points, and the dominance of centrality comparing the relative measure to those of all other points (Freeman, 1977). A star-shaped network, for example, has a central hub that is along all communication paths between other points. The other points are not along communication paths to any other points. The hub has a relative measure of centrality of 1.0 and the network also has a centrality value of 1.0, since all communication within the network must pass through the hub.

Centrality appears to be directly correlated with the efficiency of the network and the power of the individual who is more central. Freeman (1977) applied centrality measures to other studies of communication in small group settings, and concluded that centrality was related to solving problems with speed and efficiency and personal satisfaction. Likewise, Krackhardt's (1990) work correlated Freeman's measures of centrality to perceived power in a small, entrepreneurial organization.

5. Relating Network Structure to Network Effectiveness

While measures of network analysis are interesting, they are of little value unless some empirical data is offered that relates these measures to better outcomes. Before explicitly answering that question, one must consider that the above models could be applied to either markets or hierarchies. Certainly, a pure hierarchy will have bi-directional interactions, but virtually no density within the information flow until it passes up the chain of command is filtered and then disseminated to appropriate divisions across the organization. Intuitively, this low-density set of hierarchical relationships would not disseminate information as quickly or thoroughly as a network. One would expect to find more density in a network setting along with lower average distance between nodes. Measures of range would probably differ the most in a network compared to a hierarchy. The contacts in a network would be much more diverse than one would find as a manager in a hierarchy using the formal chain of command.

Table 7. Network Effectiveness Criteria (Provan and Milward, 2001: 416)

Levels of Network Analysis	Key Stakeholder Groups	Effectiveness Criteria
Community	Principals and Clients Client advocacy groups • Funders • Politicians/Regulators • General Public	• Cost to community • Building social capital • Perceptions that problem is being solved • Changes in the incidence of problem • Aggregate indicators of client well-being
Network	Principals and Agents • Primary funders and regulators • Network administrative organization • Member organizations	• Network membership growth • Range of services provided • Absence of service duplication • Creation and maintenance of network maintenance organization • Integration/coordination of services • Cost of network maintenance • Member commitment to network goals
Organization/Participant	Agents and Clients • Member agency board and management • Agency staff • Individual clients	• Agency survival • Enhanced legitimacy • Resource acquisition • Cost of services • Service access • Client outcomes • Minimize conflict across networks

From the perspective of the network as a whole, a definition of network effectiveness must be defined on multiple levels across multiple agencies. Provan and Milward (2001) offer the community, or area the network serves; the network itself; and the organization and participants as the levels among which a network should be

evaluated to satisfy multiple stakeholder perspectives. Table 7 offers a comparison of the levels, the stakeholders, and corresponding criteria which may be used to evaluate a network.

Despite this multiple combination of stakeholders and criteria, some conclusions may be drawn from empirical studies. Provan and Milward (1995) assessed local mental health networks in multiple cities drawing four conclusions on the effectiveness of those networks at improving client outcomes using multiple levels of data collection (i.e. clients, families, and case managers). In measuring the characteristics of those networks and the resultant outcomes, Provan and Milward (1995) developed the following conclusions:

- Networks are more effective when they are integrated through centralization, although networks that are integrated through a core agency and integrated through dense links among members will be less effective than those are integrated through a core agency alone.
- Networks are most effective when external controls are directly applied, rather than applied through an agency.
- Networks are most effective when a degree of stability is achieved, especially when the stability and uncertainty impacts clients.
- When the above conditions are optimal, resource scarcity will limit the effectiveness of the network. Conversely, resource abundance allows the network to range from low to high effectiveness, depending on the conditions above.

D. STRATEGIES FOR OPERATING IN A NETWORK

Given some of the notable differences between hierarchies and networks, it should not be a great surprise that operating in a network is different than operating in either a market or hierarchy. Many authors agree that operations in network settings require different strategies than operations in hierarchical organizations (Agranoff and McGuire, 2001) (Mandell and Steelman, 2003) (Mandell, 2000 and 1990) (Kickert, et al., 1997). In markets, actors coordinate based on a set of independent choices they have previously made, whereas hierarchies coordinate based on central authority, rules, and collective goals (Kickert and Koppenjan, 1997). Networks, with their interdependent

relationships, behave as neither an independent market nor a centralized hierarchy. The differences result from both limitations and opportunities that only exist in networks.

1. Network Governance

Network structures are fundamentally different than hierarchical structures. Mandell (2000) pointed out that the power and authority structure, interdependent members, and lack of boundary conditions cause different management characteristics in networks. Networks lack a formal authority structure, since members do not give up authority (Mandell, 2000). Members may choose to not fully invest or under-invest resources in the network. Members may pass along all or only some information. Ultimately, members may even choose to exit the network, although interdependency suggests that this will not happen in the short run. Nonetheless, these examples illustrate that members in networks have choices to make.

Given multiple sets of organizations with multiple values, the tradeoffs within a network become very complex. In Managing to Collaborate, Huxham and Vangen concluded that collaboration, organization, and individuals all have explicit, implicit, and hidden aims. The perceptions of what collaborative purposes each organization seeks must be negotiated across the network and over time to define the purpose of the network (2005). Two ideas emerge from this multiple stakeholders' value arrangement: 1) defining what values lead to measures of effectiveness and efficiency (i.e. quantitative or qualitative views of outcomes) must be done at the network level, and 2) improving the network's outcomes requires governance across the network.

One could debate whether management in a network is even possible. A better description of operations in a network may be governance rather than management. Mandell (1990: 32-33) argued that a manager in a network may "marshal forces," but she clearly asserted that each actor in the network "potentially has equal power." Governance in a network is, therefore, collaborative rather than directive or coercive in nature. If one actor wants to further some outcome she values, first she must get others to agree to go in that direction. Kickert and Koppenjan (1997) suggest two sets of behaviors to improve a desired outcome: guiding interaction processes within the network and altering the characteristics of the network.

2. Guiding Interaction within a Network

Governing a network involves changing a set of conditions upon which the relationships in the network are built. Since the outcomes in the network are dependent upon multiple organizations, pursuing one organization's value judgments does not mean that the network as a whole will be more effective or efficient. The actors within the network, however, can pursue relationships within the network that will affect outcomes.

a. Activating the Network

The first activity Kickert and Koppenjan (1997) suggested was to activate portions of the network that may lead to solving certain problems or achieving certain goals that are within the overall aims of the network population. Since networks often have multiple purposes, selecting actors that are likely to want to invest resources into the particular purpose is a critical part of this activity (Scharpf, 1978). All complex networks lack a complete set of relationships between all actors due to the energy involved in maintaining those relationships. Activating the network involves building the density of the network so that organizations that have common purposes may begin to work together.

b. Arranging Interaction

The risk that other actors will not deliver on their commitments is a characteristic of networks whose actors are interdependent. These risks may include underinvestment in public goods within the network (i.e. free rider behaviors) or exiting relationships before outcomes are achieved. Arranging interactions is essentially taking steps to minimize the risk of uncooperative behavior through informal and formal rules with specific actors who are essential to a valued outcome (Kickert and Koppenjan, 1997).

c. Brokerage

Complex networks with many participants and multiple aims may have participants who have not connected with one another. A broker may act as a go-between (Mandell, 1990), raising problems and solutions that bring these disparate actors together for a common purpose (Kickert and Koppenjan, 1997). Mandell suggested three types of

brokering behaviors: 1) the orchestra leader who gives directives to followers, 2) the laissez-faire leader who ensures parties come together but is not involved in the ensuing relationship, and 3) the producer who has a role in the outcome and actively participates as a leader (1990).

d. Facilitation

This type of strategic behavior in a network sets the stage for actors in the network to explore others ideas. Kickert and Koppenjan (1997) described this strategic behavior as procedural behaviors aimed at understanding the range of ideas across the actors within the network to enhance joint problem solving. Innes and Booher describe this process as consensus building which strategically generates first, second, and third order effects. These include building social, intellectual, and political capital; generating high quality agreements; and fostering innovative strategies. Second and third order effects include generating new partnerships and collaborations, joint learning, and even new norms (1999).

e. Mediation and Arbitration

While some of the processes may be similar to facilitation, the existence of conflict defines when mediation and arbitration are necessary. Mediation allows a neutral party to bring the differing actors together to discuss differences, where the responsibility for resolution remains with the parties to the conflict (Kickert and Koppenjan, 1997). Arbitration is when a neutral, third party imposes an outcome, thereby, removing the responsibility for conflict resolution from the parties (Kickert and Koppenjan, 1997).

3. Network (Re)Structuring

Network structuring may be more akin to what is traditionally thought of as strategic management in hierarchical organizations. These activities change some of the fundamental perceptions about what the purpose of the network is and how it is structured to relate to its environment. The difficulty within the network is to get agreement across the network to agree to a fundamental shift in network structure. Since

network power is shared, theorists do not agree on the efficacy of these methods. Nonetheless, there are some techniques that may be used to influence all of the interactions across the network.

a. Cognitive Interactions

An actor within the network may attempt to change the perception of actors within the network. Termeer and Koppenjan examined techniques to develop common language, prevent the exclusion of ideas, introduce new ideas, and reframe ideas as ways to manage perceptions to directly influence actors in the network. These methods pursue a goal of a coalition through the creation of variations in thought within the network (1997). Ultimately new ideas and ways of thinking will pull the entire network in new directions.

b. Social Interactions

Another way to influence the relationships across the network is to influence how the actors interact with one another. Development of new procedures, preventing the exclusion of actors, or introducing new actors may influence may affect how the actors interact with one another (Termeer and Koppenjan, 1997). An example of this would be to activate a relationship to an actor that a broker is suppressing. Going outside the broker relationship may encourage other actors to seek information directly and avoid asymmetrical information within the network.

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IV. ANALYSIS

A. APPLICATION OF THE NETWORK PERSPECTIVE TO WEAPON SYSTEM ACQUISITION

Chapter II described the acquisition system and its formal hierarchical operating structure. Chapter III introduced the network perspective and its basic assumptions and methodology. This chapter draws on the data from the APAT process model and concludes that the acquisition system has network-like properties. The implications of the acquisition system's network characteristics are explored in terms of acquisition governance.

1. Interdependencies between Actors

One of the key characteristics of a network is the relationships between the actors. Interdependencies between actors is the basis for the formation of networks (Klijn, 1997) (Powell, 1990) (Jones, et. al., 1997). The interdependencies are based on the exchange of resources, and where the actors need capital, personnel, and knowledge to accomplish their objectives (Klijn, 1997).

To deliver a weapon system, numerous actors are involved, as Tables 5, 6, and 7 synthesize for their respective acquisition phases. One of the key interdependencies during the acquisition process is the exchange of knowledge between actors. During the first three phases of the acquisition process, knowledge about what you need to buy and how the system should be designed to meet those needs is the focus of the activities. As shown in Appendix A, Process 1.0, the outputs of the Concept Refinement phase include an approved Course of Action, identification of resources needed for the next phase, approved milestone decision documents, a signed acquisition decision memorandum, and a technology development strategy. All of this knowledge is based on the collaborations among the stakeholders during each activity.

Knowledge does not come free: manpower and dollars are required to pay salaries, hire outside experts, travel to meetings, and facilitate many other activities. Early in the acquisition cycle, resources enable the building of knowledge about the

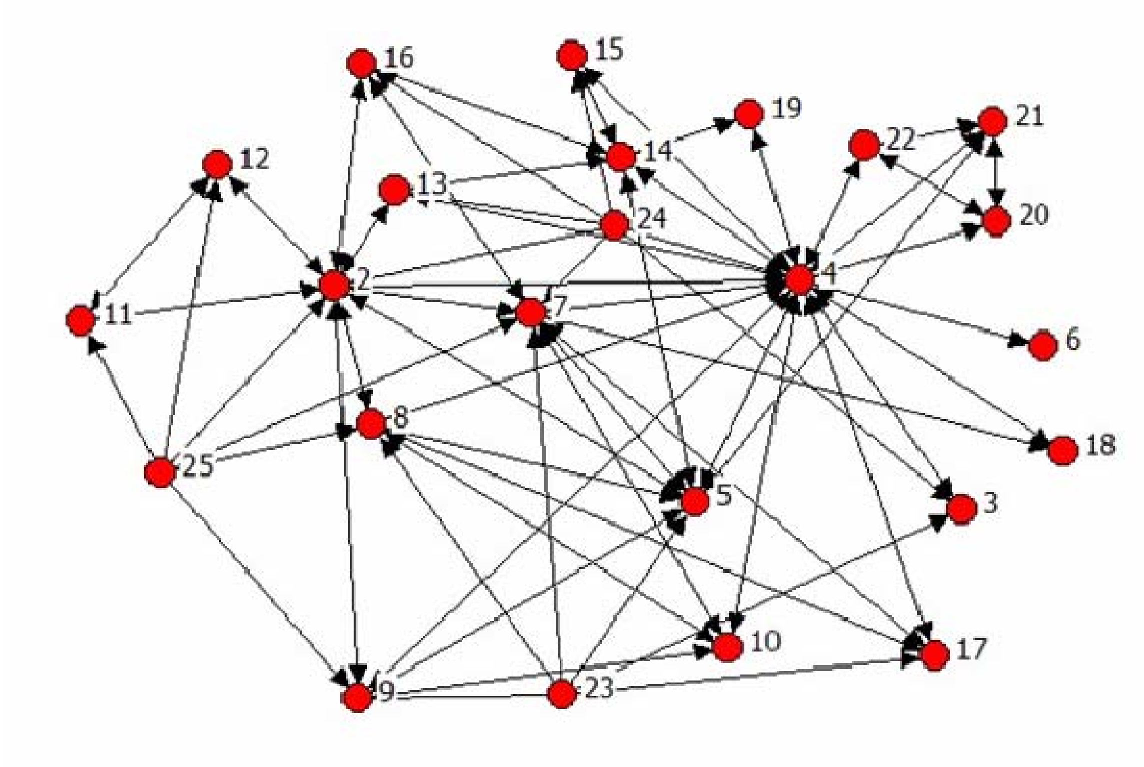
characteristics, technology, and design of the weapon system. Later, resources buy materials that become the weapon with its spare parts, support equipment, and trained personnel that are required to deliver a capability.

The interdependencies between actors for Concept Refinement are modeled in Figure 13. For modeling purposes, the interactions are assumed to be two-way, directed collaborations. The relationships are those that are specified in the Concept Refinement processes or may be inferred from the type of documents that are approved during that phase. For example, approval of a Test Evaluation Master Plan for a large program requires an OSD (DOT&E) signature. Of course, these are not the only relationships that a program might need to carry out the objectives of this phase of the acquisition cycle. This is a minimum set that one would expect to see for any major acquisition program.

The diagram shown in Figure 13 illustrates the interdependencies required to define the weapon system concept, select the course of action, and prepare for the Technology Development phase. As one could guess based on the description of responsibilities in JCIDS and the DoD 5000 series regulations, the lead acquisition organization program manager (node 4), the MAJCOM requirements organization (node 2), and the milestone decision authority (node 5) have critical roles during this phase. Freeman's measure of degree centrality (1977) for those nodes is relatively higher indicating the probability that they will control resources in the network.

Graphically, Figure 13 portrays the collaboration required with the other 22 actors to accomplish the outputs of this acquisition phase. Individually, the lead acquisition organization, the MAJCOM requirements organization, and the milestone decision authority do not interface with all of the other actors. The spreadsheet in Appendix B for the Concept Refinement interactions denotes the lead acquisition organization collaborating with 18 other actors. Of the seven actors with which the lead acquisition organization does not interface, the program manager must rely on other organizations to gather information from those parts of the network.

Figure 13. Concept Refinement Interdependencies



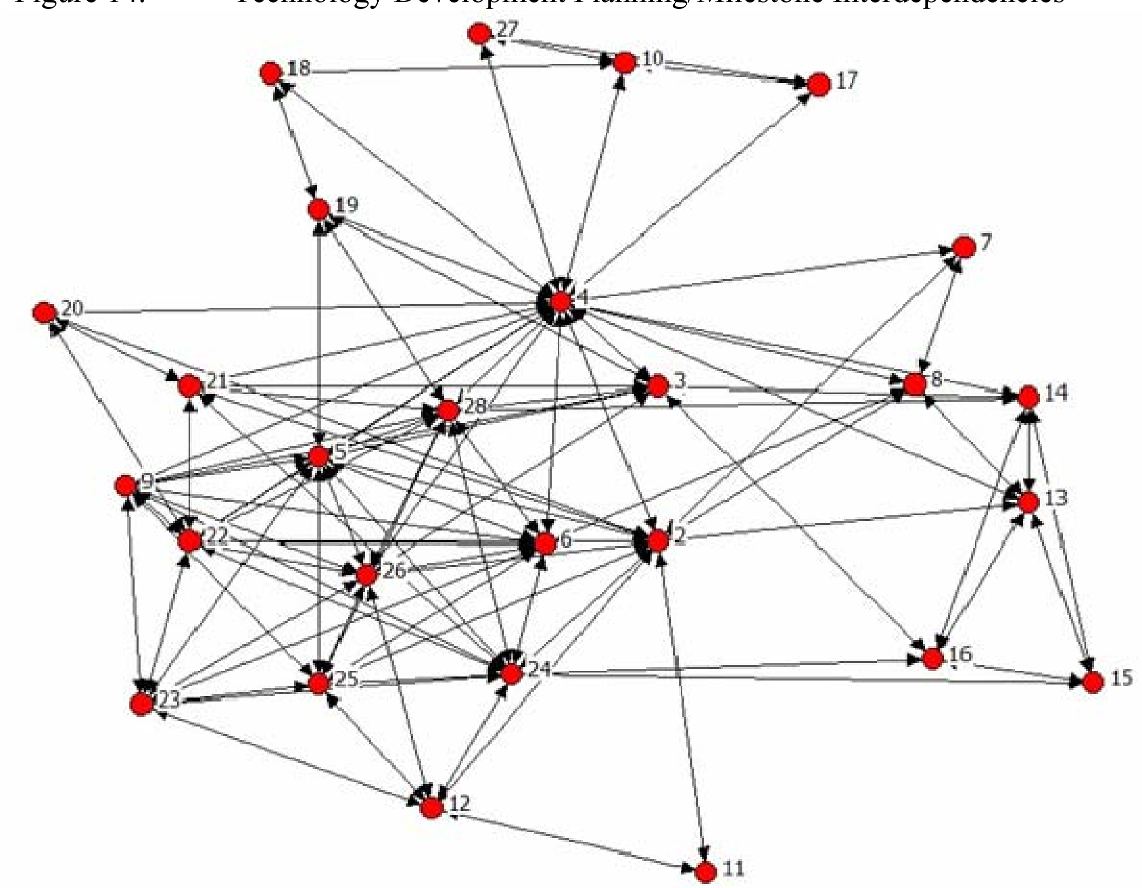
Given a weapon system concept, the purpose of the Technology Development phase of the acquisition process is to mature key technologies and to plan for weapon system development. These two activities require a diverse set of interdependencies. Maturing technology requires an in-depth understanding of the concept and system architecture as well as a diverse network of technology providers. Furthermore, the program must define the capability needs in the CDD. Along with the capability needs, operational, support, maintenance, and interoperability concepts must be refined so that the weapon system may be designed with these plans in mind. The acquisition systems engineering, test, logistics, contracting, and financial management communities collaborate with the warfighters to translate concepts into an executable acquisition program.

To understand these interactions, this analysis focuses on process 2.1.2 Identify Technologies for Maturation, process 2.1.3 Define Technology Maturation Plan, and process 2.5 Develop and Prepare Documents for Milestone B, which the APAT model

decomposed as noted in Appendix A. The diagram of the interdependencies for this phase is illustrated in Figure 14, while the matrix-view is in Appendix B.

The diagram in Figure 14 reveals that there are 28 actors involved in the acquisition program, an increase from the Concept Refinement phase. Based on degree centrality, the lead acquisition organization/program manager (node 4) remains the most central actor, maintaining many of the relationships from the previous phase. Likewise, the MAJCOM requirements organization (node 2) and the milestone decision authority (node 5) also maintain their central role. A number of other actors at the OSD and service-level become more prominent, as demonstrated by their degree centrality. The network relies on relationships with these actors to provide guidance and priorities that shape the program from an operational, acquisition strategy, and budget perspective. Therefore, the influence of the key actors is still great, but there are many relationships developing during this phase that are beyond the control of the key actors.

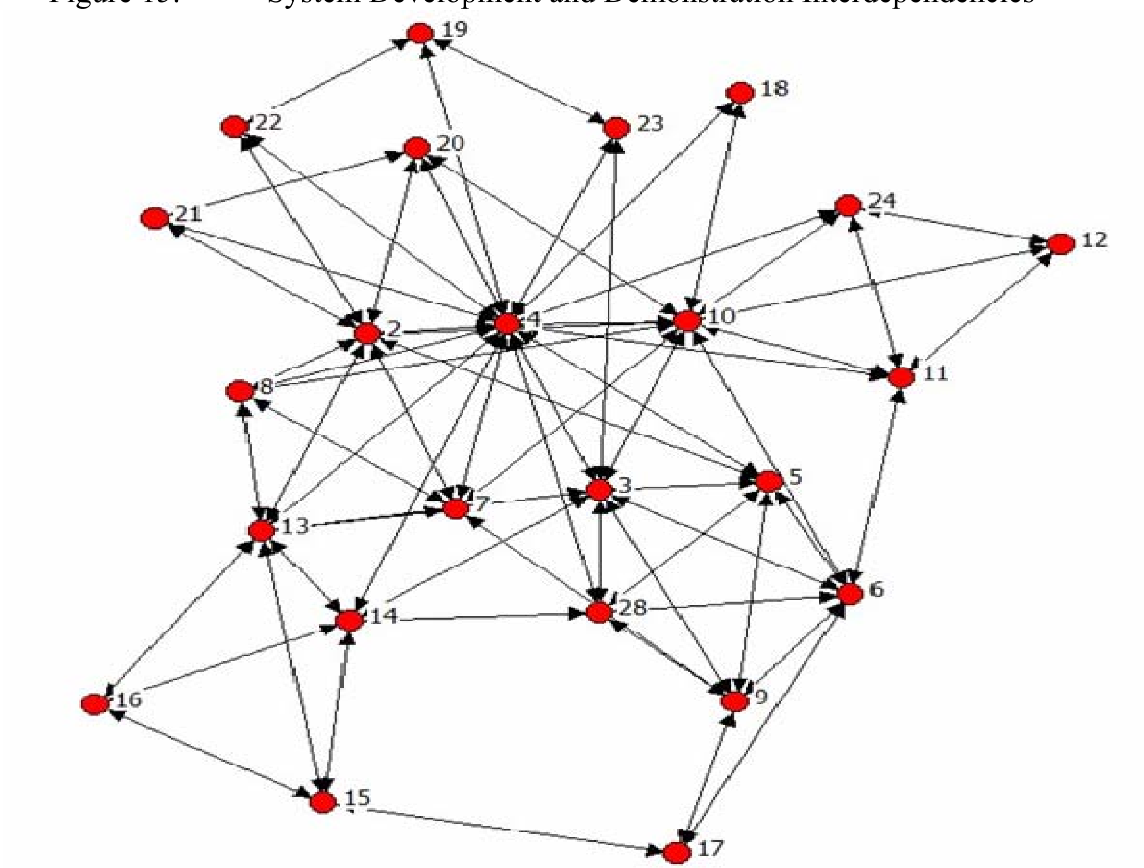
Figure 14. Technology Development Planning/Milestone Interdependencies



During the System Development and Demonstration phase, the critical activities include allocating requirements and developing a design, testing the design, and preparing for production and fielding of the system. This analysis focuses on process 3.1 Manage the Program and process 3.2.3 Develop Detailed Design from the APAT effort in Appendix A.

The diagram in Figure 15 depicts a less dense, decentralized network. In terms of degree centrality, the program manager (node 4) is still the most central actor, although the MAJCOM requirements organization (node 2) is now less central than the contractor (node 10) in influencing the network. The rise of the contractor's centrality indicates the importance of the contractor’s information to the network in a monopolistic environment. This measure of centrality for the sole non-governmental actor is of interest to those who want to influence the outcome of the network at the community, network, and organizational levels of analysis.

Figure 15. System Development and Demonstration Interdependencies



2. Multiple, Independent Actors Formed around a Project

Another characteristic of a network is that there is more than one actor who shares some common attribute that forms the context of their relationship. Using the types of network relationships from Knoke and Kuklinski (1991), the actors involved in concept refinement would share several types of relationships. Since information is a key resource, many relationships are communication relations. Relationships with industry might be described in transactional terms, where dollars are expended so that resources can be utilized to help gather information on different acquisition concepts. Finally, authority/power relations exist among the relationships. Process 1.1 in Appendix A describes the controls on the process from the Congressional, OSD, and service level. These controls may be targeted specifically at a program, such as when Congress earmarks an appropriation for a specific program.

One of the key questions is whether the actors remain independent to pursue their own objectives for the project. As noted above, there are authority/power relations exerted on the program. In fact, the lead acquisition organization program manager works for the service acquisition executive, typically through the PEO as an intermediate supervisor. Many of the actors, however, do not work for one another. Congress clearly does not work for the program manager, and the converse is also true. In addition, key collaborators such as the MAJCOM and the lead acquisition organization do not work for one another even though they are in the same service. If the lead acquisition organization and the MAJCOM requirements organization had a dispute, they would have to resolve it at the Chief of Staff of the Air Force/Secretary of the Air Force level. As noted in Chapter II, issues are not resolved typically at that level. Instead, the actors utilize their relationship with one another to collaborate and work through issues.

3. Lasting, Stable Relationships between Actors

The final characteristic to be analyzed is the pattern of relationships between actors over time. Again, the literature stresses the importance of this characteristic based on the need to strengthen relationships (Klijn, 1997). On long-term acquisition programs with both complexity and uncertainty, this characteristic is important to allow actors to

establish trust with one another. This trust enables actors to make transaction-specific investments that will further the objectives of both the actors and the network.

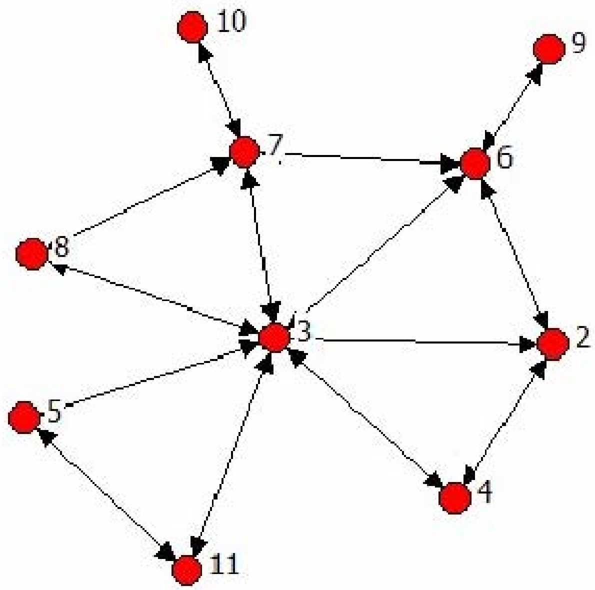
To examine this variable, the set of actors in the first three acquisition phases were analyzed to determine if the relationship spanned multiple acquisition phases, which could last from a couple of years to over a decade. The analysis is inexact since only select processes from the Technology Development phase and System Development and Demonstration phase were analyzed. Nonetheless, a group of 10 actors form 13 enduring relationships that span the formation and development of an acquisition program. This group and their relationships are displayed in Table 8. The network among this core group is graphically displayed in Figure 16.

High degree centrality among this core group denotes the actors who continually control resources over time. Not surprisingly, the program office has the highest degree centrality within this persistent group of core actors. Interestingly, the MAJCOM budget organization and modernization budget integrator on Air Staff, SAF/AQX, also have high degree centrality stemming from their control over the fiscal resources needed to execute the acquisition program.

Table 8. Core Network during Early Acquisition Phases

	(2) MAJCOM Requirements	(3) Program Office	(4) Milestone Decision Authority	(5) Contractor	(6) MAJCOM Budget	(7) SAF/AQX	(8) Service Acq Exec (SAF/AQ	(9) SAF/FM	(10) AF/XP	(11) Center Contracting
(2) MAJCOM Requirements	0	1	1	0	1	0	0	0	0	0
(3) Program Office	1	0	1	1	1	1	1	0	0	1
(4) Milestone Decision Authority (MDA)	1	1	0	0	0	0	0	0	0	0
(5) Contractor	0	1	0	0	0	0	0	0	0	1
(6) MAJCOM Budget	1	1	0	0	0	1	0	1	0	0
(7) SAF/AQX	0	1	0	0	1	0	1	0	1	0
(8) Service Acq Exec (SAF/AQ)	0	1	0	0	0	1	0	0	0	0
(9) SAF/FM	0	0	0	0	1	0	0	0	0	0
(10) AF/XP	0	0	0	0	0	1	0	0	0	0
(11) Center Contracting	0	1	0	1	0	0	0	0	0	0

Figure 16. Acquisition Core Network



B. NETWORK GOVERNANCE

A network view of acquisition allows an analyst to look at outcomes and management strategies in a new way. Rather than focusing on accountability, the focus shifts to understanding how to enable the network as a whole to create greater value. As Provan and Milward (2001) suggested, the effectiveness of the network ought to be analyzed at the community, network, and participant level. Understanding the outcomes desired from acquisition programs across the Congressional and warfighting community, the acquisition community, and the individual organizations within the network allows a holistic analysis of how the network ought to be structured to accomplish these desires.

1. Network Performance

A review of the data in Appendix B supports the conclusion that the Lead Acquisition Organization/Program Manager is the most central actor within the acquisition process in terms of degree centrality. Furthermore, this actor has the greatest range of relationships, brokering information from the warfighter, budget community, technology community, and contractor. This places the Program Manager in a very

important position in the network. Of course, the Program Manager derives this centrality from his purported responsibility to deliver a weapon system within cost, schedule, and performance.

Not all program managers perform equally. Some may have networks that are unstable, and the manager is unable to stabilize them. Other managers may have perfectly adequate networks but they are unable to understand their significance. Whatever the case, understanding the structure of the network should enable program managers to understand the environment within which successful programs are executed.

Further, an understanding of the network allows an analysis of second-order effects due to changes in the network. Provan and Milward (1995) concluded that resource scarcity would limit the effectiveness of any network. When resources are adequate, however, factors such as centralization, direct external controls, and stability may also affect the outcomes of networks. An understanding of the structure of the acquisition program network would allow an analysis of the effects of changes using modeling. The resultant outcomes could be analyzed at the participant, network, and community level. In other words, a network view of acquisition would allow individual participants to understand how their outcomes and the network's outcomes would be affected from the continuing change in policy, resources, and players in the acquisition system.

2. Network Strategies for Weapon Systems

If improved outcomes are desired at the community, network, and organization level, an understanding of the workings of the network should be accompanied by the ability to improve interactions within the network and possibly restructure the network. Several techniques that might be used to guide interactions within the structure of the acquisition network are suggested below.

a. Guiding Interactions in the Acquisition Network

Activating the network establishes actors who would push outcomes in a direction that the community desires. JCIDS suggests that the community desires weapons systems that allow joint warfighting. The process of using strategic guidance to

fund actors within the requirements and acquisition community who also value joint warfighting would allow the network to build a joint common purpose. Furthermore, the key players in Table 8 and Figure 16 should support relationships with peripheral actors within the network that promote interoperability. Those key players who broker resources within the network might be able to arrange interactions where actors who do not value joint outcomes are isolated and starved for resources.

The core network actors would likely face conflict from other actors as they attempt to influence relationships across the network. Facilitation, mediation, and arbitration would allow the core actors to constructively influence relationships in the network. IPPD along with the IPT structure essentially encompass this behavior where a wide range of ideas are sought to solve network problems. Further, consensus building within the network would be important, not only for the immediate solution but also to encourage continued interaction in the future.

b. Restructuring the Acquisition Network

Network theory is unclear on whether an actor, or even a coalition of actors, can affect all of the interactions across the network to pursue an objective. Within the defense acquisition system, this theoretical debate is experienced quite often. Then Secretary of Defense Dick Cheney attempted to kill the V-22 Osprey program. Even as powerful an actor as the Secretary of Defense was unsuccessful. Representative Curt Weldon reinserted the program in the appropriations bill, while the Marines were quietly advocating for the program.

Nonetheless, the implementation of JCIDS provides an example of how to restructure the relationships in the network. The value of jointness affects the interactions within the defense acquisition system. Since the joint staff and the Functional Capabilities Boards control the requirements, the services that are not willing to play in a joint arena would not be in a position to become the sponsoring agency. A set of social interactions has evolved under JCIDS that values joint weapon systems.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. Research Question

The focus of this professional report was to answer the following research question: does the DoD weapon system acquisition process behave as a network?

The characterization of the "Big A" acquisition system as a complex interaction of the JCIDS subsystem, the PPBE subsystem, and the defense acquisition subsystem identified multiple stakeholders who value different outcomes. Each of these players attempts to utilize some form of hierarchy to break down tasks and assign responsibility to ensure task accomplishment. Figure 2, Figure 3, and Figure 6 all display some of the key outputs and players within JCIDS, PPBE, and acquisition, respectively.

However, the APAT process model revealed a more complex, interactive process among the JCIDS, PPBE, and the acquisition subsystems. Table 2, Table 3, and Table 4 portray the key players in the first three phases of the acquisition cycle. An analysis of these players reveals that many do not work for one another and may have differing objectives. Furthermore, examination of the key activities within the Concept Refinement, Technology Development, and System Development and Demonstration phases, and the interactions of the key players who were involved in the controls, inputs, activities, and outputs of each subsystem, revealed key interdependencies and long, stable relationships among independent actors. This analysis led to the conclusion that weapon system acquisition can be conceptualized as a network.

2. Further Refinements

Analysis of the APAT process model data also led to an understanding that centrality is not equally distributed within the network. The lead acquisition organizations/program manager is a central figure who has the greatest number of relationships and is most central to the network measured in terms of degree of centrality. Despite the program manager's lack of a high position within a hierarchical model,

network analysis reveals that the program manager has the greatest number of contacts and interactions within the network.

Additionally, there is a core group of actors who have a persistent set of relationships during the early, critical stages of the acquisition process. While the program manager is well-placed within this core group, there are other important actors who deal with budgets and have sustained relationships over time. Understanding the structure of this group and their relationships with the rest of the network will be important in helping the program manager develop strategies to govern the network and influence changes for improved network performance and outcomes.

B. RECOMMENDATIONS

1. Validate the Model

First, the data gathered in the APAT model were intended to serve as a framework to understand the current acquisition process as it applies to a majority of programs. The scope of the data gathering process limited the ability to focus on all interactions. Therefore, activities such as milestone decisions were described as an exercise in document writing. Those involved in the APAT effort recognized that the documents generated for a milestone decision were actually the culmination of a set of interactions to gather data and develop a strategy for a particular portion of the acquisition program. For this effort, the official who approved the document and the program office WIPT were assumed to be the only participants. This is in fact probably not true. Participants might include other organizations, depending on the subject matter of the program and local procedures.

Therefore, the model serves as a good first step to begin to explore certain interactions within the acquisition system. If a certain set of interactions or a set of actors are of interest, gathering more detailed data would be valuable to further the understanding of the network and validating the model.

2. Network Framework to Study Improved Outcomes

The data gathering effort for the APAT model was not prescriptive. While the sponsors of the effort were interested in recognizing areas for improvement, the model

was meant to describe the current process. There are reasons for the patterns of relationships established in the model, but there also may be improved ways of interacting.

Indeed, the network model, once validated, could be utilized as a framework to assess program success. Those who control acquisition policy or who participate in acquisition programs likely would be interested in studying how the networks of these programs of interest differ from the norm. The DoD Directive 5000.1 gives the program manager and milestone decision authority flexibility to decide what the correct set of activities and relationships should be for a particular acquisition program. Studying network models of similar programs might enable decision-makers to tailor their efforts and focus resources on valuable relationships. Alternatively, acquisition strategies could be modeled to discover if information flows efficiently and effectively given several scenarios for organizing a program.

3. Simulate Changes to the Acquisition System

Of course, there are number of challenges within the acquisition process. Consistently delivering cost, schedule, and performance is rare as Augustine and Fabini (1983), Jones (1996), and McNutt (1998) agreed. Improving consistency of the system has spawned a number of changes some of which are initially declared successful, only to be later discredited for their "unintended consequences." An example is the initiative to give the contractor Total System Performance Responsibility. This initiative gave the contractor more flexibility and responsibility for the performance of the acquisition program. Unfortunately, the effects of this change were probably not studied using a network analysis. The decision-makers acted upon the ideology that the marketplace solved all their problems.

A number of changes to the acquisition system are being considered today. JCIDS mandates that programs have been have a Net-Ready Key Performance Parameter (CJCSI 3170.01E, 2005). This attempt to build a communication system by mandating interoperability from those who will utilize the system is much like the chicken and the egg conundrum. First, the architecture of the network must have some definition. Those who are developing a network and the users of the network must collaborate to solve this

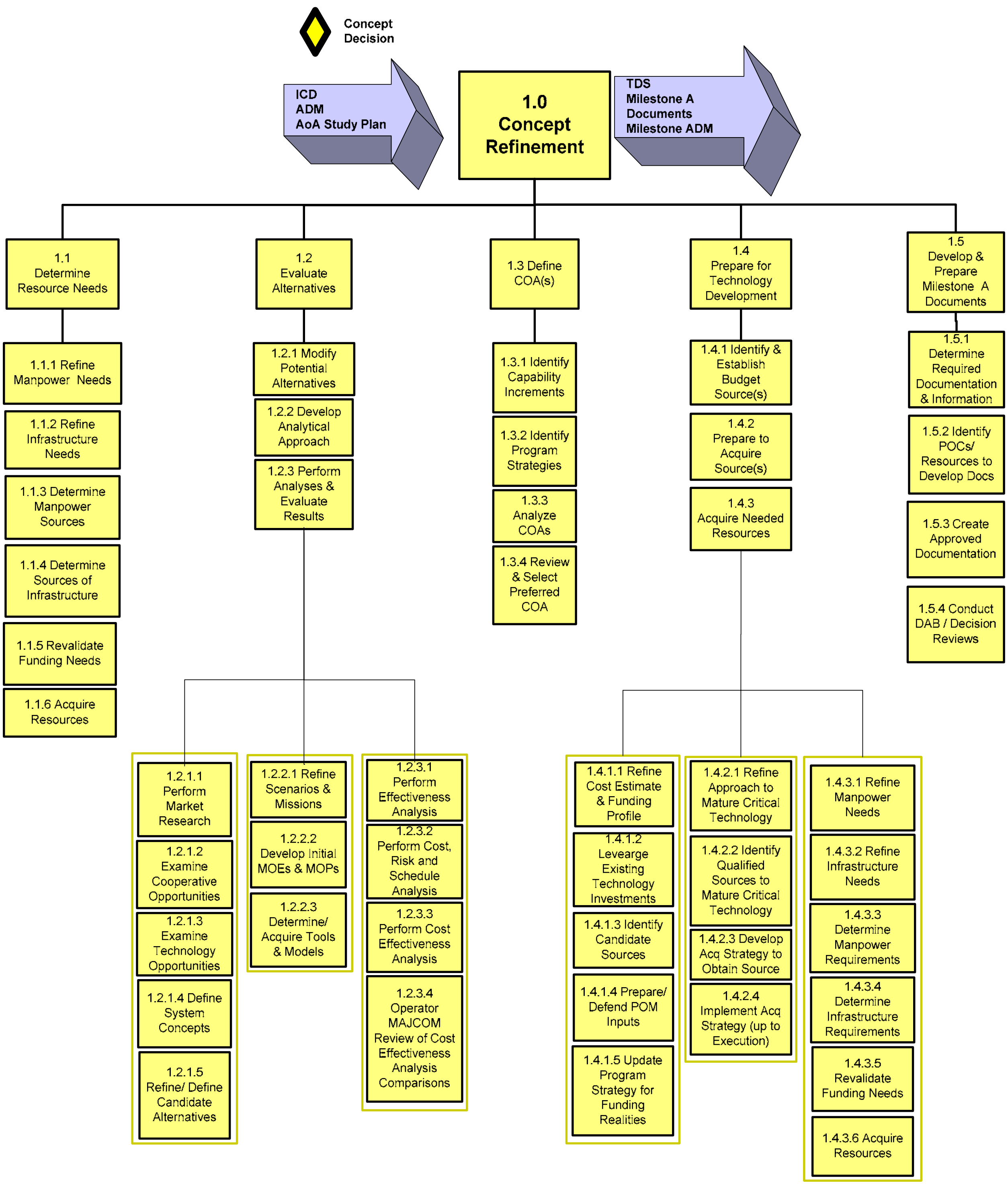
problem. A network analysis to identify who is involved and how they are collaborating would be more beneficial rather than mandating a change and hoping that those actors in the network would comply.

C. SUMMARY

Networks describe both formal and informal ways of getting things done in the acquisition system. The marketplace rarely delivers what the DoD needs at the quantity that it is needed. Some commodities may be purchased in the marketplace, but the uncertainties associated with DoD needs do not allow firms to match their supply to demand. Also, many of DoD's needs are based on interoperability between programs that must be defined before the market can react to this need. The largest transactions, which involve the lion's share of the modernization budget, rely on the interactions between JCIDS, PPBE, and the acquisition system. A hierarchy exists to account for the resources input into the process. However, the complexities and dynamic nature of the process can best be described as a network of actors who use their relationships to affect outcomes.

Would Glenn Curtiss recognize this network that delivers today's innovative stealth aircraft, advanced combat systems, and ships? He probably would. If you brought Mr. Curtiss into a meeting with a program manager, MAJCOM requirements officer, and a contractor, he would feel right at home. Mr. Curtiss is no stranger to hierarchies given the size of the Curtiss Aircraft Company. Nonetheless, he knew that innovation occurs when a network of collaborators shares ideas to solve their common problems.

APPENDIX A DOD 5000 PROCESS MODEL



1.1 Determine Resource Needs for Concept Refinement

Controls	Manpower Models, Laws	Funding & Time Constraints, Leadership Directives	Organizational UMD, STE Caps, OSD Mandates, Statutory Mandates	USAF & Org Priorities,	PPBE Process, Appropriation Laws, New Start Authority,	PPBE Process, Appropriation Laws, New Start Authority, Existing Contracts
Trigger	Trigger: Concept Decision ADM Signed					
Input	ICD *(Operator MAJCOM)* ADM *(MDA)* AoA Study Plan *(Operator MAJCOM)* Lead Acq Organization Identified *(AFMC)*	ICD *(Operator MAJCOM)* ADM *(MDA)* AoA Study Plan *(Operator MAJCOM)* Lead Acq Organization Identified *(AFMC)*	ICD *(Operator MAJCOM)* ADM *(MDA)* AoA Study Plan *(Operator MAJCOM)* Lead Acq Organization Identified *(AFMC)* Identified Manpower Skills & Numbers *(Operator MAJCOM, Lead Acq Org,)*	ICD *(Operator MAJCOM)* ADM *(MDA)* AoA Study Plan *(Operator MAJCOM)* Lead Acq Organization Identified *(AFMC)* Identified Infrastructure Needs *(Operator MAJCOMs, Lead Acq Orgs)*	ICD *(Operator MAJCOM)* ADM *(MDA)* AoA Study Plan *(Operator MAJCOM)* Lead Acq organization Identified *(AFMC)* Specific Manpower identified Specific Infrastructure identified	Funding Requirement *(Operator MAJCOM, Lead Acq Org)* Specific Manpower identified Specific Infrastructure identified
Process	1.1.1 Refine Manpower Needs *(Operator MAJCOM, Lead Acq Org,)*	1.1.2 Refine Infrastructure Needs *(Operator MAJCOM, Lead Acq Org,)*	1.1.3 Determine Manpower Sources *(Operator MAJCOM, Lead Acq Org,)*	1.1.4 Determine Sources of Infrastructure *(Operator MAJCOM, Lead Acq Org,)*	1.1.5 Revalidate Funding Needs *(Operator MAJCOMs, Lead Acq Orgs)*	1.1.6 Acquire Resources *(Operator MAJCOM, Lead Acq Org,)*
Activities	Analyze Management & Subject Matter Expertise Requirements		Make Organic/ Non-Organic Decision	Make Organic/ Non-Organic Decision		May or may not require contract action
Output	Identified Manpower Skills & Numbers *(Operator MAJCOM, Lead Acq Org,)*	Identified Infrastructure Needs *(Operator MAJCOMs, Lead Acq Orgs)*	Specific Manpower identified (both organic or non) *(Operator MAJCOMs, Lead Acq Org)*	Specific Infrastructure identified (both organic or non) *(Operator MAJCOM, Lead Acq Org,)*	Funding Requirement *(Operator MAJCOM, Lead Acq Org)*	Funding Acquired *(Operator MAJCOM, Lead Acq Org)* Specific Manpower Acquired Specific Infrastructure Acquired
Metrics	Not at this point in time	Not at this point in time	Authorized vs. Assigned Manpower	IRR (Infrastructure Readiness Review- CE)	Unfunded Requirement	Authorized vs. Assigned Manpower
Mechanisms	Manpower Models, SM Expertise, Certification Requirements	AFMC - IPT (REUs), SM Expertise	Functional Leads, Prior Experience	Base (CE) Facilities Plan, Facilities Modernization Plan	Cost Models, SME's	Other Available Resources, FFRDC's, Reprogramming Authority

1.2.1 Modify Potential Alternatives

	1.2.1.1	1.2.1.2	1.2.1.3	1.2.1.4	1.2.1.5
Triggers & Attributes		CONTROL: ITAR			
Input	DOD/ USAF Guidance ICD AoA Study Plan FSA (Functional Solution Analysis) - Data Products	DOD/ USAF Guidance ICD AoA Study Plan FSA (Functional Solution Analysis) - Data Products	DOD/ USAF Guidance ICD AoA Study Plan FSA (Functional Solution Analysis) - Data Products Results of Market Research from 1.2.1.1	Results from 1.2.1.1 & 1.2.1.2 List of System/ Sub-System Impacts to Alts Tech Maturity Assessments DOD/ USAF Guidance ICD AoA Study Plan FSA (Functional Solution Analysis) - Data Products	Set of System Attributes & Performance System Interdependencies & Interoperabilities Definitions of Critical Enabling Technologies ICD Existing Architectures
Process	1.2.1.1 Perform Market Research *(Operator MAJCOM, Lead Acq Org)*	1.2.1.2 Examine Cooperative Opportunities	1.2.1.3 Examine Technology Opportunities	1.2.1.4 Define System Concepts	1.2.1.5 Refine/ Define Candidate Alternatives
Activities		Research Within Service, Joint, Allies Capabilities	Consult DOD Lab Efforts		Refine SV's in Architectures Alternative Impact(s) of the concept to the Existing Architecture Impacts or limitations of the pre-existing architecture
Output	ICD Feedback Potentially Feasible Technology Industrial Capacity Innovative Concepts Commercial Products Available for Adaptation	Opportunities for Within Service, Joint & Ally (Cost Sharing) Alternatives Leverage Common Systems for Multiple Capabilities	List of System/ Sub-System Impacts to Alts Tech Maturity Assessments	Set of System Attributes & Performance System Interdependencies & Interoperabilities Definitions of Critical Enabling Technologies	Candidate Alternatives

1.2.2 Develop Analytical Approach

Trigger	Trigger: AoA Assigned		
Input	System Threat Assessment AoA Study Plan ICD SPG Scenarios & Other Capability Studies Candidate Alternatives (input from 1.2.1)	Approved Scenarios & Details for Modeling System Threat Assessment AoA Study Plan ICD SPG Scenarios & Other Capability Studies Candidate Alternatives (input from 1.2.1)	MOEs & MOPs System Threat Assessment AoA Study Plan ICD SPG Scenarios & Other Capability Studies Candidate Alternatives (input from 1.2.1) Scenarios & Details for Modeling
Process	1.2.2.1 Refine Scenarios & Missions	1.2.2.2 Develop Initial MOEs & MOPs	1.2.2.3 Determine/ Acquire Tools & Models
Activities	Develop Data Sets Review w/ Intel Community	Coordinate/ Collaborate Reviews of MOEs & MOPs	Identify Needed Engineering, Costs, & Operational Models Determine Availability of existing Models Modify/ Refine Models
Output	Approved Scenarios & Details for Modeling	Initial MOEs & MOPs (Threshold & Objective Levels)	Conceptual Engineering, Costs, & Operational Models

1.2.3 Perform Analyses & Evaluate Results

Notes
1. Assess Technology Sub System is a part of the Risk Analysis in 1.2.3.2

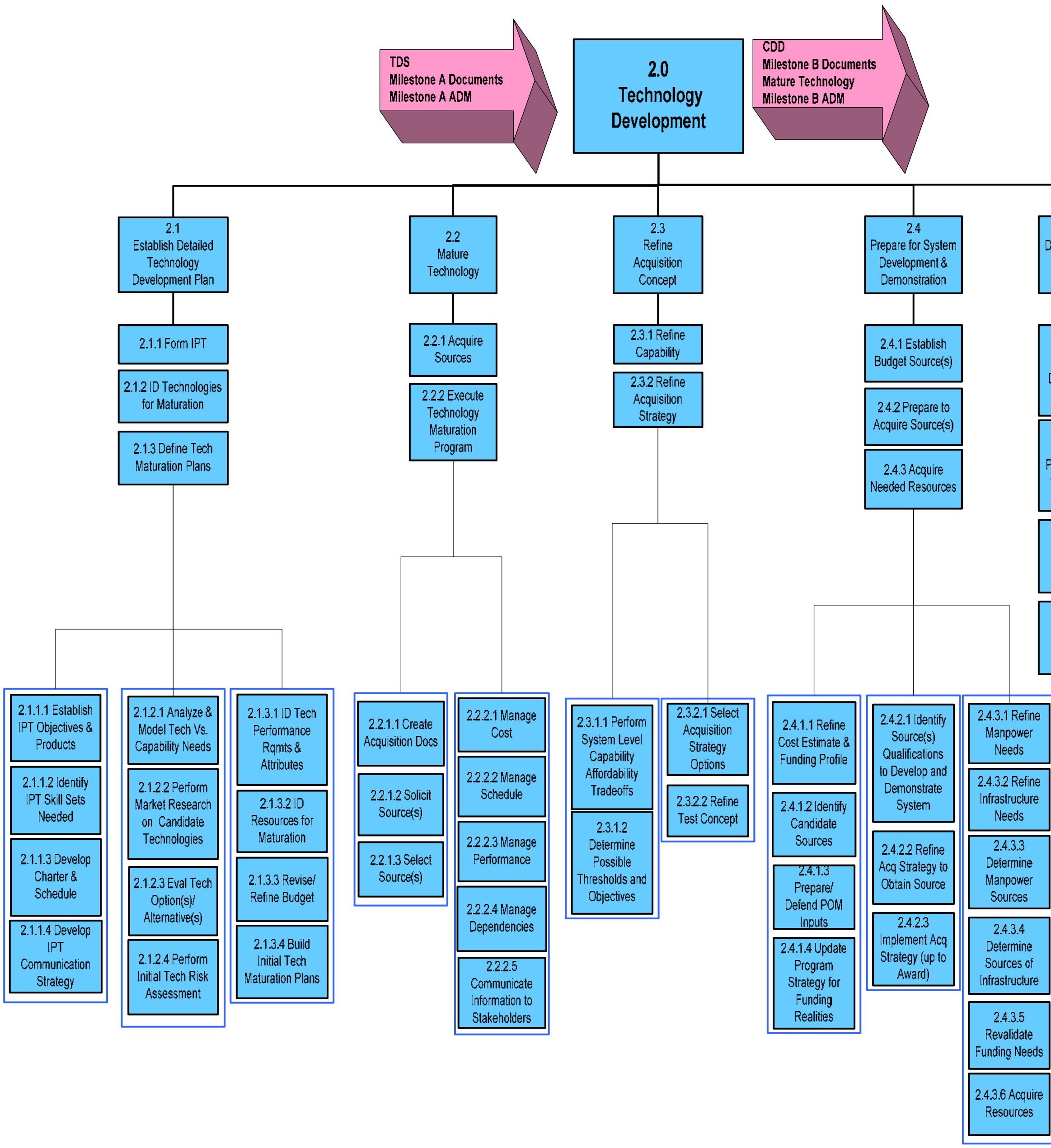
Input	Candidate Alternatives (input from 1.2.1) AoA Study Plan ICD Approved Scenarios & Details for Modeling Initial MOEs & MOPs (Threshold & Objective Levels) Conceptual Engineering, Costs, & Operational Models	Performance Assessment against MOEs & MOPs AoA Study Plan ICD Candidate Alternatives (input from 1.2.1) Approved Scenarios & Details for Modeling Initial MOEs & MOPs (Threshold & Objective Levels) Conceptual Engineering, Costs, & Operational Models	Risk Assessment Cost and Schedule Assessment Performance Assessment against MOEs & MOPs Performance & Capability Drivers(Sensitivities)	ICD Relative Comparison of Alternatives
Process	1.2.3.1 Perform Effectiveness Analysis	1.2.3.2 Perform Cost, Risk and Schedule Analysis	1.2.3.3 Perform Cost Effectiveness Analysis	1.2.3.4 Operator MAJCOM Review of Cost Effectiveness Analysis Comparisons
Activities	Assess Technical Performance / Capability Identify Sensitivities	Perform Risk Analysis Perform Cost & Schedule Analysis	Analyze Results of Cost Effectiveness Analysis	
Output	Performance Assessment against MOEs & MOPs Performance & Capability Drivers(Sensitivities)	Risk Assessment Cost and Schedule Assessment	Relative Comparison of Alternatives	Preferred Alternative

1.3 Define Alternative Courses of Action COA(s)

Input	ICD Feedback on AoA Out brief Preferred Alternative (input from 1.2.3.4)	ICD Feedback on AoA Out brief Preferred Alternative (input from 1.2.3.4) Potential Capability Increments	ICD Feedback on AoA Out brief Preferred Alternative (input from 1.2.3.4) Potential Program Strategies for COAs	Preferred Alternative (input from 1.2.3.4) ICD Relative Comparison of COAs
Process	1.3.1 Identify Capability Increments	1.3.2 Identify Program Strategies	1.3.3 Analyze COAs	1.3.4 Review & Select Preferred COA
Activity	Brainstorm Potential Incremental Approaches Conduct User Interaction Consider Operator MAJCOM Budget & TOA	Evaluate Historical COA Conduct Systems Engineering Analysis Develop Cost, Schedule, Risk and Effectiveness Estimates Conduct Operator MAJCOM Interaction - review Consider Operator MAJCOM Budget & TOA	Conduct Operator MAJCOM Interaction - Review Consider Operator MAJCOM Budget & TOA	Conduct Lead Acq Review MDA Approves COA Operator MAJCOM Reviews & Approves COA
Output	Potential Capability Increments	Potential Program Strategies for COAs	Relative Comparison of COAs	Approved COA Indication of Next Phase(s)

1.4 Prepare for Technology Development

Trigger	COA Selected		
Input	MAJCOM Budget ICD Approved COA *(Operator MAJCOM)* (input from 1.3.4)	TDS (input from 1.5.1) ICD Approved COA *(Operator MAJCOM)* (input from 1.3.4) Budget Sources Identified	Acq Strategy to Obtain Source(s) TDS (input from 1.5.1) Funding Profile (input from 1.4.1) Approved COA *(Operator MAJCOM)* (input from 1.3.4) ICD
Process	1.4.1 Identify & Establish Budget Source(s)	1.4.2 Prepare to Acquire Source(s)	1.4.3 Acquire Needed Resources (manpower, facilities, etc.)
Output	Updated Program Strategy	Source(s) Selected Agreement in place with Source(s) pending MSA	Specific Infrastructure acquired (both organic or non) *(Operator MAJCOM, Lead Acq Org.)* Funding Requirement *(Operator MAJCOM, Lead Acq Org)*


TDS
Milestone A Documents
Milestone A ADM
2.0 Technology Development
CDD
Milestone B Documents
Mature Technology
Milestone B ADM
2.1 Establish Detailed Technology Development Plan
2.2 Mature Technology
2.3 Refine Acquisition Concept
2.4 Prepare for System Development & Demonstration
2.5 Develop & Prepare Milestone B Documents
2.1.1 Form IPT
2.1.2 ID Technologies for Maturation
2.1.3 Define Tech Maturation Plans
2.2.1 Acquire Sources
2.2.2 Execute Technology Maturation Program
2.3.1 Refine Capability
2.3.2 Refine Acquisition Strategy
2.4.1 Establish Budget Source(s)
2.4.2 Prepare to Acquire Source(s)
2.4.3 Acquire Needed Resources
2.5.1 Determine Required Documentation & Information
2.5.2 Identify POCs / Resources to Develop Docs
2.5.3 Create Approved Documentation
2.5.4 Conduct DAB/Decision Reviews
2.1.1.1 Establish IPT Objectives & Products
2.1.1.2 Identify IPT Skill Sets Needed
2.1.1.3 Develop Charter & Schedule
2.1.1.4 Develop IPT Communication Strategy
2.1.2.1 Analyze & Model Tech Vs. Capability Needs
2.1.2.2 Perform Market Research on Candidate Technologies
2.1.2.3 Eval Tech Option(s)/ Alternative(s)
2.1.2.4 Perform Initial Tech Risk Assessment
2.1.3.1 ID Tech Performance Rqmts & Attributes
2.1.3.2 ID Resources for Maturation
2.1.3.3 Revise/ Refine Budget
2.1.3.4 Build Initial Tech Maturation Plans
2.2.1.1 Create Acquisition Docs
2.2.1.2 Solicit Source(s)
2.2.1.3 Select Source(s)
2.2.2.1 Manage Cost
2.2.2.2 Manage Schedule
2.2.2.3 Manage Performance
2.2.2.4 Manage Dependencies
2.2.2.5 Communicate Information to Stakeholders
2.3.1.1 Perform System Level Capability Affordability Tradeoffs
2.3.1.2 Determine Possible Thresholds and Objectives
2.3.2.1 Select Acquisition Strategy Options
2.3.2.2 Refine Test Concept
2.4.1.1 Refine Cost Estimate & Funding Profile
2.4.1.2 Identify Candidate Sources
2.4.1.3 Prepare/ Defend POM Inputs
2.4.1.4 Update Program Strategy for Funding Realities
2.4.2.1 Identify Source(s) Qualifications to Develop and Demonstrate System
2.4.2.2 Refine Acq Strategy to Obtain Source
2.4.2.3 Implement Acq Strategy (up to Award)
2.4.3.1 Refine Manpower Needs
2.4.3.2 Refine Infrastructure Needs
2.4.3.3 Determine Manpower Sources
2.4.3.4 Determine Sources of Infrastructure
2.4.3.5 Revalidate Funding Needs
2.4.3.6 Acquire Resources

2.1.2 Identify Technologies for Maturation

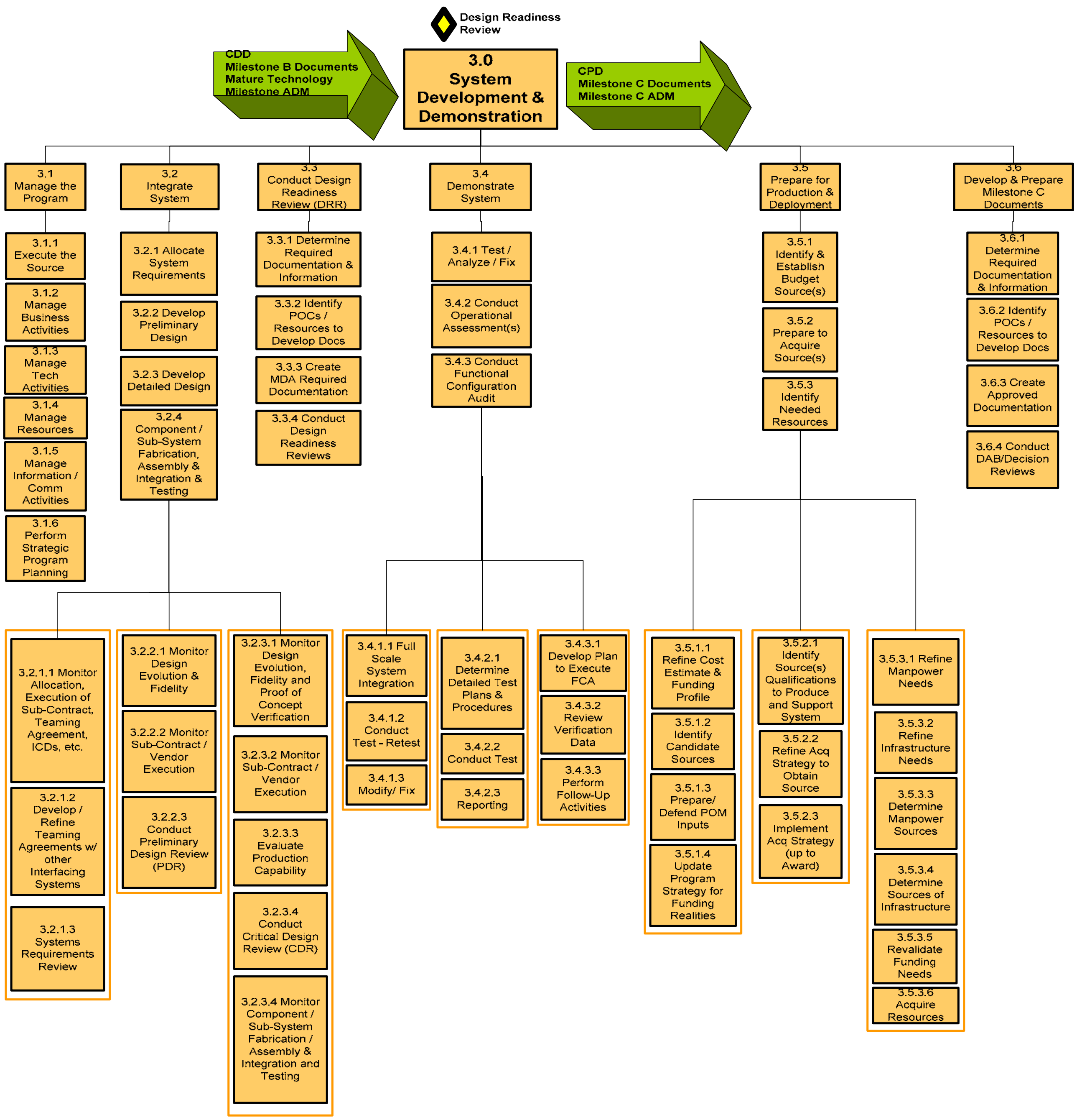
	2.1.2.1	2.1.2.2	2.1.2.3	2.1.2.4
Trigger	Milestone A ADM			
Input	Approved CoA (input from 1.3.4) *(Acq Lead)* TDS (input from 1.5.1) *(Acq Lead)* ICD *(MAJCOM)*	Library of Historical TRAs *(OSD AT&L)* Approved CoA (input from 1.3.4) TDS (input from 1.5.1) *(Acq Lead)* ICD *(MAJCOM)* Candidate Technology (Abilities & Shortfalls) *(Sponsor Agency, IPT)*	Political Influence Approved CoA (input from 1.3.4) *(Acq Lead)* TDS (input from 1.5.1) *(Acq Lead)* ICD *(MAJCOM)* Initial Set of Candidate Technologies *(Sponsor Agency, IPT)*	Selected Tech Option(s)/ Alternative(s) *(IPT, Industry, Labs, etc.)*
Process	2.1.2.1 Analyze & Model Tech Vs. Capability Needs *(IPT from 2.1.1)*	2.1.2.2 Perform Market Research on Candidate Technologies *(IPT)*	2.1.2.3 Eval Tech Option(s)/ Alternative(s) *(IPT)*	2.1.2.4 Perform Initial Tech Risk Assessment *(IPT)*
Activities	Id Thresholds & Objectives Address Tech Integration Challenges & Dependencies	Eval Industrial-base (includes foreign) Eval Gov't Market Share Eval Maturity & Viability	Selection of Technology Balanced Technology Against Other Issues (Systems Engineering, etc.)	Id & Prioritize Tech Risk Down select Tech Options & Alternative(s) Id Risk Mitigation Activities Dependencies
Output	Candidate Technology Abilities & Shortfalls *(Sponsor Agency, IPT)*	Initial Set of Candidate Technologies *(Sponsor Agency, IPT)* Market Research Report *(Sponsor Agency, IPT)*	Selected Tech Option(s)/ Alternative(s) *(IPT, Industry, Labs, etc.)* Tech Readiness Assessment *(Acq Lead, MDA, IPT)*	Initial Technical Risk Mgmt Plan *(Acq Lead)*
Mechanisms	Mechs - None Identified		TRL(s)	
Metrics	Metrics - None Identified			

2.1.3 Define Technology Maturation Plan

Trigger	Milestone A ADM			
Input	ICD *(MAJCOM)* TDS (input from 1.5.1) *(Acq Lead)* Selected Tech Option(s)/Alternative(s) (input from 2.1.2.3) *(IPT, Industry, Labs, etc.)* Initial Technical Risk Mgmt Plan (input from 2.1.2.4) *(Acq Lead)*	Market Research Report (input from 2.1.2.2) ICD *(MAJCOM)* TDS (input from 1.5.1) *(Acq Lead)* Selected Tech Option(s)/ Alternative(s) (input from 2.1.2.3) Initial Technical Risk Mgmt Plan (input from 2.1.2.4)	Budget *(Sponsor Agency)* Personnel & Infrastructure for Maturation (	Personnel & Infrastructure for Maturation Performance Rqmts & Attributes Budget Resolution (POM or no $$) Exit Criteria
Process	2.1.3.1 ID Tech Performance Rqmts & Attributes *(IPT)*	2.1.3.2 ID Resources for Maturation *(Acq Lead, IPT)*	2.1.3.3 Revise/ Refine Budget *(IPT)*	2.1.3.4 Build Initial Tech Maturation Plans (includes Transition Plans) *(IPT)*
Activities	Define Detailed Objectives, Thresholds, & Metrics	Personnel ID Infrastructure ID Make Organic/ Contractor Decisions	Revise/ Refine Cost Estimate(s) Compare & Resolve Cost Estimate vs. Budget	Id Tech Sources Allocate Acquisition Responsibilities per Technology (Lead Exec Agency) Conduct Industry Day(s) & Other Outreach Activities
Output	Performance Rqmts & Attributes	Personnel & Infrastructure for Maturation *(Acq Lead)*	Budget Resolution (POM or no $$) *(Acq Lead, Sponsor Agency)*	Initial Tech Maturation Plan *(Sponsor Agency, Acq Lead)*
Mechanisms	TRL Level			

2.5 Develop and Prepare Milestone B Documents

Trigger	Milestone A ADM Exit Criteria			
Input	Inputs to CDD (input from 2.3.1.2) Approved COA (MAJCOM) (input from 1.3.4) Acquisition Strategy (input from 2.3.3.1)	List of Required Documents	Inputs to CDD (input from 2.3.1.2) Approved COA (MAJCOM) (input from 1.3.4) Acquisition Strategy (input from 2.3.3.1) TRA (input from 2.2.2.3) ICD Updated Tech Maturation Plan (input from 2.2.2) TEMP Plan Inputs (input from 2.3.3.2) Program Strategy (Funding) (input from 2.4.1.4)	Approved Milestone B Documents POM/Budget (input from 2.4.1) DRAFT ADM
Process	2.5.1 Determine Required Documentation & Information	2.5.2 Identify POCs / Resources to Develop Docs	2.5.3 Create Approved Documentation	2.5.4 Conduct DAB/Decision Reviews
Activity	Timeline / Schedule for Completion Solicit MDA Requirements		Gather Information for Required Documents Develop Documents Informal Coordination of Documents Formal Coordination of Documents TEMP / Test Plan Acquisition Program Baseline (APB) System Engineering Plan (SEP) ICD Affordability Assessment PSMP Develop Exit Criteria C4ISP CDD IMP / IMS Life Cycle Management Plan COA Tech Readiness Assessment DRAFT ADM PMD Work Breakdown Structure (WBS) AoA J&A System Threat Assessment (STA) Clinger-Cohen Act Compliance Clinger-Cohen Act Certification TDS	Prepare Briefs for DAB/Decision Reviews Conduct Pre Briefs for Coordination Conduct Review for Approval (MDA)
Output	List of Required Documents	List of Assigned POCs / Resources to Develop Docs	Approved Milestone B Documents	Signed Milestone B ADM



Design Readiness Review
CDD
Milestone B Documents
Mature Technology
Milestone ADM
3.0 System Development & Demonstration
CPD
Milestone C Documents
Milestone C ADM
3.1 Manage the Program
3.1.1 Execute the Source
3.1.2 Manage Business Activities
3.1.3 Manage Tech Activities
3.1.4 Manage Resources
3.1.5 Manage Information / Comm Activities
3.1.6 Perform Strategic Program Planning
3.2 Integrate System
3.2.1 Allocate System Requirements
3.2.2 Develop Preliminary Design
3.2.3 Develop Detailed Design
3.2.4 Component / Sub-System Fabrication, Assembly & Integration & Testing
3.3 Conduct Design Readiness Review (DRR)
3.3.1 Determine Required Documentation & Information
3.3.2 Identify POCs / Resources to Develop Docs
3.3.3 Create MDA Required Documentation
3.3.4 Conduct Design Readiness Reviews
3.4 Demonstrate System
3.4.1 Test / Analyze / Fix
3.4.2 Conduct Operational Assessment(s)
3.4.3 Conduct Functional Configuration Audit
3.5 Prepare for Production & Deployment
3.5.1 Identify & Establish Budget Source(s)
3.5.2 Prepare to Acquire Source(s)
3.5.3 Identify Needed Resources
3.6 Develop & Prepare Milestone C Documents
3.6.1 Determine Required Documentation & Information
3.6.2 Identify POCs / Resources to Develop Docs
3.6.3 Create Approved Documentation
3.6.4 Conduct DAB/Decision Reviews
3.2.1.1 Monitor Allocation, Execution of Sub-Contract, Teaming Agreement, ICDs, etc.
3.2.1.2 Develop / Refine Teaming Agreements w/ other Interfacing Systems
3.2.1.3 Systems Requirements Review
3.2.2.1 Monitor Design Evolution & Fidelity
3.2.2.2 Monitor Sub-Contract / Vendor Execution
3.2.2.3 Conduct Preliminary Design Review (PDR)
3.2.3.1 Monitor Design Evolution, Fidelity and Proof of Concept Verification
3.2.3.2 Monitor Sub-Contract / Vendor Execution
3.2.3.3 Evaluate Production Capability
3.2.3.4 Conduct Critical Design Review (CDR)
3.2.3.4 Monitor Component / Sub-System Fabrication / Assembly & Integration and Testing
3.4.1.1 Full Scale System Integration
3.4.1.2 Conduct Test - Retest
3.4.1.3 Modify/ Fix
3.4.2.1 Determine Detailed Test Plans & Procedures
3.4.2.2 Conduct Test
3.4.2.3 Reporting
3.4.3.1 Develop Plan to Execute FCA
3.4.3.2 Review Verification Data
3.4.3.3 Perform Follow-Up Activities
3.5.1.1 Refine Cost Estimate & Funding Profile
3.5.1.2 Identify Candidate Sources
3.5.1.3 Prepare/ Defend POM Inputs
3.5.1.4 Update Program Strategy for Funding Realities
3.5.2.1 Identify Source(s) Qualifications to Produce and Support System
3.5.2.2 Refine Acq Strategy to Obtain Source
3.5.2.3 Implement Acq Strategy (up to Award)
3.5.3.1 Refine Manpower Needs
3.5.3.2 Refine Infrastructure Needs
3.5.3.3 Determine Manpower Sources
3.5.3.4 Determine Sources of Infrastructure
3.5.3.5 Revalidate Funding Needs
3.5.3.6 Acquire Resources

3.1 Manage the Program

Process	3.1.1 Execute the Source (Program Manager, Contract Officer)	3.1.2 Manage Business Activities (Program Manager)	3.1.3 Manage Tech Activities (Chief Engineer	3.1.4 Manage Resources (e.g. Manpower, Infrastructure, Facilities, Security,etc.) (Program Manager)	3.1.5 Manage Information / Comm Activities (Program Manager)	3.1.6 Perform Strategic Program Planning (Program Manager)
Input	MAJCOM Budget (Sponsor Agency) Milestone B Documents (e.g. Approved CDD, Milestone B ADM, etc.) (SPO Team, Sponsor for CDD) Agreement in place with Source(s) prior to MS B (Team) Source(s) Selected (Program Office Team)	MAJCOM Budget (Sponsor Agency) Definitized Agreement (Contractor, Contracting Officer)	Definitized Agreement Feedback / Direction to Source Program Impacts (CAIV)	Specific Infrastructure Acquired (Acquisition Center) Specific Manpower Acquired (Acquisition Center) Resource Funding Acquired (Sponsor Agency) PMD (MDA)	Updated Business Program Documentation Updated Technical Documentation Updated Resource Documentation Definitized Agreement Acquisition Program Baseline(APB) (MDA) MAJCOM Budget Program Impacts	Updated Business Program Documentation Updated Technical Documentation Updated Resource Documentation Impacts to COA(Program Manager) Definitized Agreement Acquisition Program Baseline(APB) MAJCOM Budget Program Impacts
Activity	Inorganic vs. Organic Negotiate / Integrate MODs Price Negotiation Memorandum (PNM) Baseline the Contract (IBR) Debrief - Sources Not Selected Assimilate MDA Comments Post Award Conferences Partnership Agreements Risk Assessment - Integrated Update	Manage Cost Manage Schedule Manage Risk Manage Source Agreements Manage Change Establish / Manage Baseline CPAR Evaluate Performance Monitor EVMs Contract Change(s) Manage Budget Update Business Program Documentation Manage GFE, GFI & GFP Establish Joint Management Processes	Manage Risk Manage Tech Performance Manage Sustainment Manage TEST Establish / Manage Baseline Update technical Documentation Award Fees Evaluate Performance Configuration Mgmt	Manage Infrastructure Manage Manpower Update Personnel Documentation Update Facilities Documentation	Reporting Manage Change Manage Expectations Manage Tasker & Suspenses (Requirements that require a formal response) External Mgmt Comm Internal Mgmt Comm	POM Inputs Increment Mgmt Expectation Mgmt
Output	Definitized Agreement (Contractor, Contracting Officer)	Feedback / Direction to Source (Contractor,MDA) Source Performance Data (Team) Updated Budget (PM, Financial Support) Program Impacts (CAIV) (Sponsor Agency, MDA) Program Status (Sponsor Agency, MDA) Updated Business Program Documentation (MDA)	Updates to Requirements Baseline (Team, Contractor) Technical Baseline(s) (Team, Contractor) Updated Test Plans (Team, Contractor) Updated PSMP (Team, Contractor) Updated SEP (Team, Contractor, MDA) Program Impacts (CAIV) (Sponsor Agency, MDA) Program Status(Sponsor Agency, MDA) Updated Technical Documentation (Team, Contractor)	Updated Resource Requirements (Spaces & Faces, Infrastructure) (Acquisition Center) Program Impacts (MDA,PEO, Team, Contractor) Organizational Structure (Program Office) Resourcing Status (Program Office) Updated Resource Documentation (Acquisition Center)	Responses to Inquiries (Inquirer) Required Program reporting (Various) Audit Report (Audit requestor)	Updated Expectation Mgmt (Sponsor, MDA) Updated COA / CDD (Sponsor) Updated Budget (Sponsor, MDA, Congress, Team, Contractor) Program Gaps and Disconnects (Sponsor, MDA, PEO, Team) Updated Acquisition Strategy (MDA, PEO)

3.2.3 Develop Detailed Design

Key Assumptions & Issues
1. Hardware & Software CDRs can be completed independently and incrementally

Inputs

- Sub Contract Management Plan
- Approved Allocated Baseline
- Updated System Spec
- Approved Preliminary Design
- Approved Component Sub System Specs
- Capability Development Document
- TEMP, SEP, SAMP, C4ISP

- Design and Manufacturing Data

- Preliminary Manufacturing Plan
- Refined System Spec
- IMP
- Component Engr Development Models, Prototypes, Unit Code
- Final Sub-System and Component Specifications
- Proposed Drawings
- Proposed Software Requirements Specs
- Updated TEMP, SEP, SAMP, C4ISP
- Refined ICDs (Interface Control Document)
- Proposed Deficiency Corrective Action Plans

- Final Sub-System and Component Specifications
- Proposed Drawings
- Proposed Software Requirements Specs
- Refined ICDs (Interface Control Document)
- Refined System Spec
- Preliminary Manufacturing Plan

Process

- 3.2.3.1 Monitor Design Evolution, Fidelity and Proof of Concept Verification
- 3.2.3.2 Monitor Sub-Contract / Vendor Execution
- 3.2.3.3 Evaluate production capability (including major/ critical suppliers)
- 3.2.3.4 Conduct Critical Design Review (CDR)
- 3.2.3.5 Monitor Component / Sub-System Fabrication / Assembly and Integration and Testing

Activities

- Update Verification Planning
- Refine Production & Manufacturing Strategy/ Initiate Manufacturing Plan
- Refine Logistics & Support Strategy
- Update SEP Products
- Develop DRAFT Design to Meet PDR Rqmts
- Conduct Component Lab Testing to Verify Design Concept
- Complete Proposed Design Incorporating Verification Results
- Initiate Incremental Production Readiness Reviews

- Maintain Robust Systems Engineering
- Demonstrate Control of Production Systems (major/ critical suppliers)
- Capability assessment of critical processes
- Assess diminishing manufacturing sources and material shortages (DMS)

- Verifying Exit Criteria

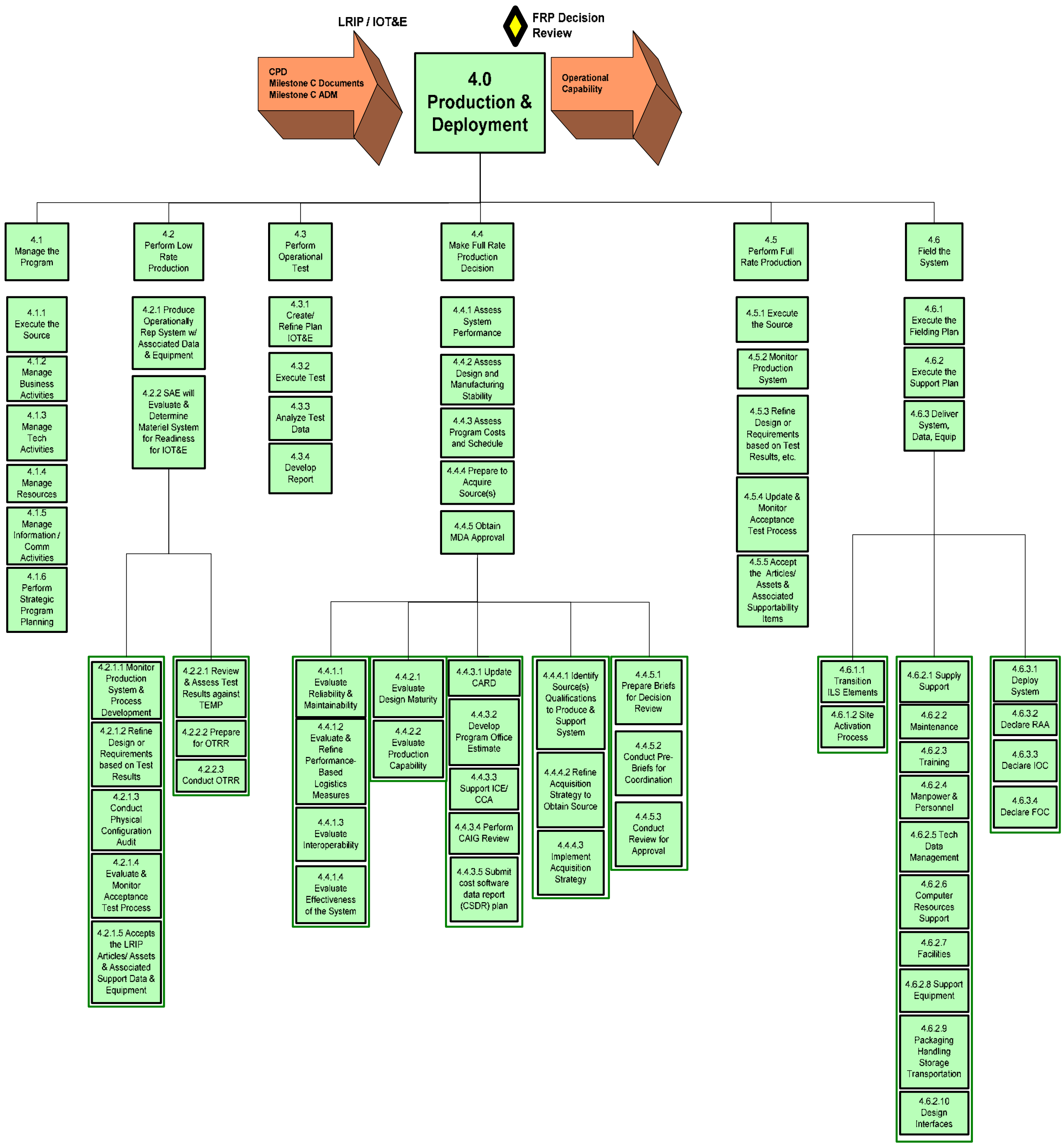
Outputs

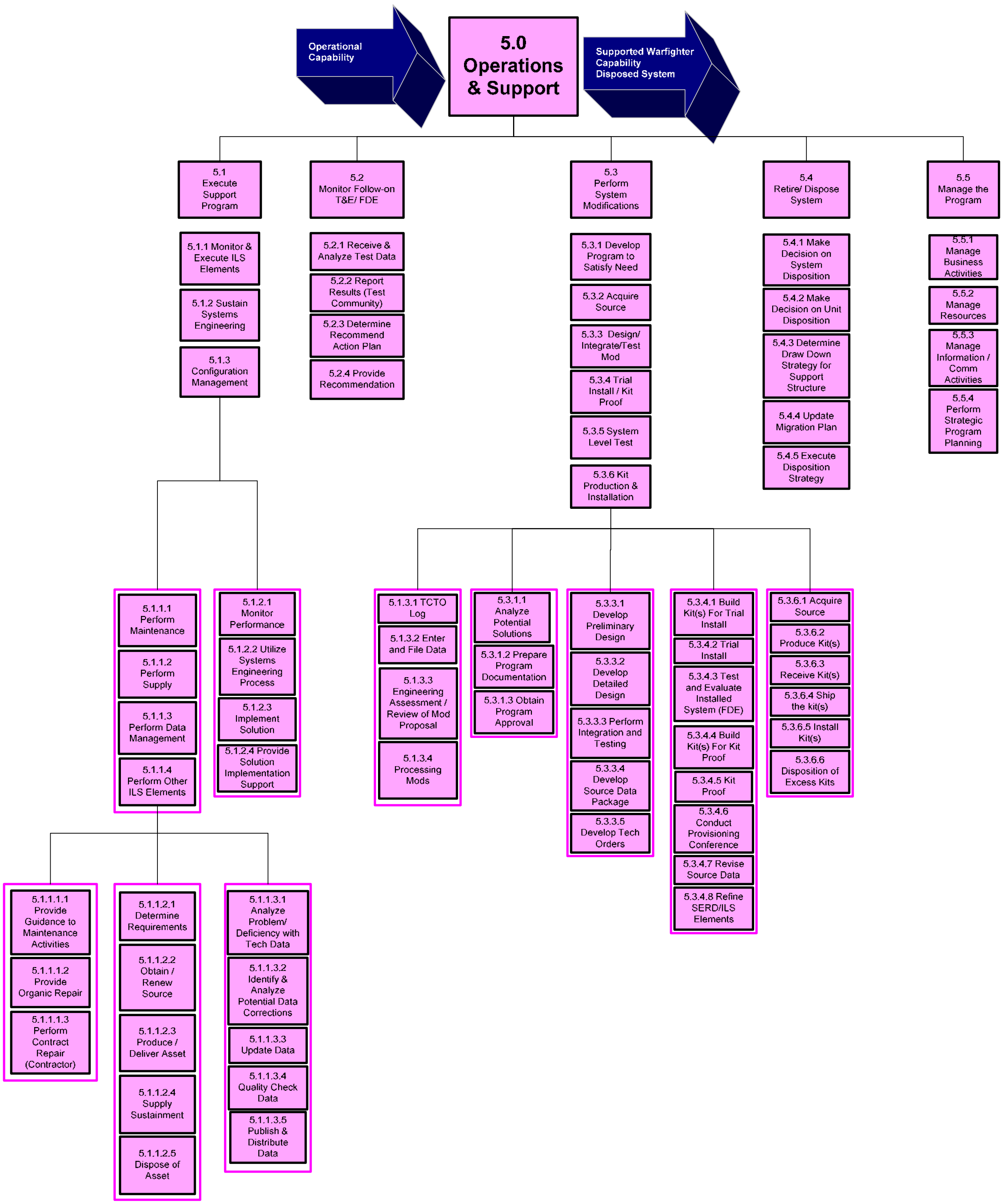
- Updated Allocations & Agreements
- Final Sub-System and Component Specifications
- Proposed Drawings
- Proposed Software Requirements Specs
- Updated TEMP, SEP, SAMP, C4ISP
- Refined ICDs (Interface Control Document)
- Proposed Deficiency Corrective Action Plans
- Component Engr Development Models, Prototypes, Unit Code
- Refined System Spec
- Preliminary Manufacturing Plan
- Results of Production Readiness Review

- SPD Assessment
- PRR Report
- Updated Acquisition Strategy

- Approved Software Requirements Specs
- Approved Drawings
- Approved ICDs (Interface Control Document)
- Approved Deficiency Corrective Action Plans
- Refined Sub-System and Component Specs
- Approved System Spec
- Functional Baseline
- Approved Manufacturing Plan

Refine
- Approved Software Requirements Specs
- Approved Drawings
- Approved ICDs (Interface Control Document)
- Approved Deficiency Corrective Action Plans
- Refined Sub-System and Component Specs
- Approved System Spec
- Functional Baseline
- Approved Manufacturing Plan


LRIP / IOT&E
FRP Decision Review
CPD
Milestone C Documents
Milestone C ADM
4.0 Production & Deployment
Operational Capability
4.1 Manage the Program
4.1.1 Execute the Source
4.1.2 Manage Business Activities
4.1.3 Manage Tech Activities
4.1.4 Manage Resources
4.1.5 Manage Information / Comm Activities
4.1.6 Perform Strategic Program Planning
4.2 Perform Low Rate Production
4.2.1 Produce Operationally Rep System w/ Associated Data & Equipment
4.2.2 SAE will Evaluate & Determine Materiel System for Readiness for IOT&E
4.2.1.1 Monitor Production System & Process Development
4.2.1.2 Refine Design or Requirements based on Test Results
4.2.1.3 Conduct Physical Configuration Audit
4.2.1.4 Evaluate & Monitor Acceptance Test Process
4.2.1.5 Accepts the LRIP Articles/ Assets & Associated Support Data & Equipment
4.2.2.1 Review & Assess Test Results against TEMP
4.2.2.2 Prepare for OTRR
4.2.2.3 Conduct OTRR
4.3 Perform Operational Test
4.3.1 Create/ Refine Plan IOT&E
4.3.2 Execute Test
4.3.3 Analyze Test Data
4.3.4 Develop Report
4.4 Make Full Rate Production Decision
4.4.1 Assess System Performance
4.4.2 Assess Design and Manufacturing Stability
4.4.3 Assess Program Costs and Schedule
4.4.4 Prepare to Acquire Source(s)
4.4.5 Obtain MDA Approval
4.4.1.1 Evaluate Reliability & Maintainability
4.4.1.2 Evaluate & Refine Performance-Based Logistics Measures
4.4.1.3 Evaluate Interoperability
4.4.1.4 Evaluate Effectiveness of the System
4.4.2.1 Evaluate Design Maturity
4.4.2.2 Evaluate Production Capability
4.4.3.1 Update CARD
4.4.3.2 Develop Program Office Estimate
4.4.3.3 Support ICE/ CCA
4.4.3.4 Perform CAIG Review
4.4.3.5 Submit cost software data report (CSDR) plan
4.4.4.1 Identify Source(s) Qualifications to Produce & Support System
4.4.4.2 Refine Acquisition Strategy to Obtain Source
4.4.4.3 Implement Acquisition Strategy
4.4.5.1 Prepare Briefs for Decision Review
4.4.5.2 Conduct Pre-Briefs for Coordination
4.4.5.3 Conduct Review for Approval
4.5 Perform Full Rate Production
4.5.1 Execute the Source
4.5.2 Monitor Production System
4.5.3 Refine Design or Requirements based on Test Results, etc.
4.5.4 Update & Monitor Acceptance Test Process
4.5.5 Accept the Articles/ Assets & Associated Supportability Items
4.6 Field the System
4.6.1 Execute the Fielding Plan
4.6.2 Execute the Support Plan
4.6.3 Deliver System, Data, Equip
4.6.1.1 Transition ILS Elements
4.6.1.2 Site Activation Process
4.6.2.1 Supply Support
4.6.2.2 Maintenance
4.6.2.3 Training
4.6.2.4 Manpower & Personnel
4.6.2.5 Tech Data Management
4.6.2.6 Computer Resources Support
4.6.2.7 Facilities
4.6.2.8 Support Equipment
4.6.2.9 Packaging Handling Storage Transportation
4.6.2.10 Design Interfaces
4.6.3.1 Deploy System
4.6.3.2 Declare RAA
4.6.3.3 Declare IOC
4.6.3.4 Declare FOC


Operational Capability
5.0 Operations & Support
Supported Warfighter Capability Disposed System
5.1 Execute Support Program
5.2 Monitor Follow-on T&E/ FDE
5.3 Perform System Modifications
5.4 Retire/ Dispose System
5.5 Manage the Program
5.1.1 Monitor & Execute ILS Elements
5.1.2 Sustain Systems Engineering
5.1.3 Configuration Management
5.2.1 Receive & Analyze Test Data
5.2.2 Report Results (Test Community)
5.2.3 Determine Recommend Action Plan
5.2.4 Provide Recommendation
5.3.1 Develop Program to Satisfy Need
5.3.2 Acquire Source
5.3.3 Design/ Integrate/Test Mod
5.3.4 Trial Install / Kit Proof
5.3.5 System Level Test
5.3.6 Kit Production & Installation
5.4.1 Make Decision on System Disposition
5.4.2 Make Decision on Unit Disposition
5.4.3 Determine Draw Down Strategy for Support Structure
5.4.4 Update Migration Plan
5.4.5 Execute Disposition Strategy
5.5.1 Manage Business Activities
5.5.2 Manage Resources
5.5.3 Manage Information / Comm Activities
5.5.4 Perform Strategic Program Planning
5.1.1.1 Perform Maintenance
5.1.1.2 Perform Supply
5.1.1.3 Perform Data Management
5.1.1.4 Perform Other ILS Elements
5.1.2.1 Monitor Performance
5.1.2.2 Utilize Systems Engineering Process
5.1.2.3 Implement Solution
5.1.2.4 Provide Solution Implementation Support
5.1.3.1 TCTO Log
5.1.3.2 Enter and File Data
5.1.3.3 Engineering Assessment / Review of Mod Proposal
5.1.3.4 Processing Mods
5.3.1.1 Analyze Potential Solutions
5.3.1.2 Prepare Program Documentation
5.3.1.3 Obtain Program Approval
5.3.3.1 Develop Preliminary Design
5.3.3.2 Develop Detailed Design
5.3.3.3 Perform Integration and Testing
5.3.3.4 Develop Source Data Package
5.3.3.5 Develop Tech Orders
5.3.4.1 Build Kit(s) For Trial Install
5.3.4.2 Trial Install
5.3.4.3 Test and Evaluate Installed System (FDE)
5.3.4.4 Build Kit(s) For Kit Proof
5.3.4.5 Kit Proof
5.3.4.6 Conduct Provisioning Conference
5.3.4.7 Revise Source Data
5.3.4.8 Refine SERD/ILS Elements
5.3.6.1 Acquire Source
5.3.6.2 Produce Kit(s)
5.3.6.3 Receive Kit(s)
5.3.6.4 Ship the kit(s)
5.3.6.5 Install Kit(s)
5.3.6.6 Disposition of Excess Kits
5.1.1.1.1 Provide Guidance to Maintenance Activities
5.1.1.1.2 Provide Organic Repair
5.1.1.1.3 Perform Contract Repair (Contractor)
5.1.1.2.1 Determine Requirements
5.1.1.2.2 Obtain / Renew Source
5.1.1.2.3 Produce / Deliver Asset
5.1.1.2.4 Supply Sustainment
5.1.1.2.5 Dispose of Asset
5.1.1.3.1 Analyze Problem/ Deficiency with Tech Data
5.1.1.3.2 Identify & Analyze Potential Data Corrections
5.1.1.3.3 Update Data
5.1.1.3.4 Quality Check Data
5.1.1.3.5 Publish & Distribute Data

APPENDIX B ACQUISITION NETWORKS

A. CONCEPT REFINEMENT NETWORK

	(2) MAJCOM Requirements	(3) AFMC	(4) Lead Acquisition Organization	(5) Milestone Decision Authority (MDA)	(6) Federally Funded Research and Development Centers (FFRDC)	(7) Other Service Programs	(8) Joint Programs	(9) Allied Programs	(10) Industry	(11) Defense Intelligence Agency (DIA)	(12) Combatant Commanders (COCOM)	(13) MAJCOM Budget	(14) SAF/AQ	(15) SAF/FM	(16) AF/XP	(17) Air Force Research Lab (AFRL)	(18) Center Contracting (PK)	(19) Acquisition Center of Excellence (ACE)	(20) AFMC/DO	(21) AF/TE	(22) DOT&E	(23) OSD	(24) AF	(25) Joint Staff	
(2) MAJCOM Requirements	0	0	1	1	0	1	1	1	0	1	1	1	0	0	1	0	0	0	0	0	0	0	1	1	11
(3) AFMC	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	3
(4) Lead Acquisition Organization	1	1	0	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	1	0	1	0	18
(5) Milestone Decision Authority (MDA)	1	0	1	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	8
(6) Federally Funded Research and Development Centers (FFRDC)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
(7) Other Service Programs	1	0	1	1	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	10
(8) Joint Programs	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	7
(9) Allied Programs	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	6
(10) Industry	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
(11) Defense Intelligence Agency (DIA)	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
(12) Combatant Commanders (COCOM)	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
(13) MAJCOM Budget	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	4
(14) Service Acq Exec (SAF/AQ)	0	0	1	1	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	6
(15) SAF/FM	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	3
(16) AF/XP	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	4
(17) Air Force Research Lab (AFRL)	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4
(18) Center Contracting (PK)	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
(19) Acquisition Center of Excellence (ACE)	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
(20) AFMC/DO	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	3
(21) AF/TE	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	4
(22) DOT&E	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	3
(23) OSD	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	8
(24) AF	1	1	1	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	1	0	1	9
(25) Joint Staff	1	0	0	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	8

B. TECHNOLOGY DEVELOPMENT PLANNING/MILESTONE NETWORK

	(2) MAJCOM Requirements	(3) PEO	(4) Lead Acquisition Organization	(5) Milestone Decision Auth (MDA)	(6) OSD/NII	(7) AFMC/LG	(8) MAJCOM LG	(9) OSD (AT&L)	(10) Industry	(11) Defense Intelligence Agency (DIA)	(12) Combatant CCs	(13) MAJCOM Budget	(14) SAF/AQX	(15) SAF/FM	(16) AF/XP	(17) Air Force Research Lab (AFRL)	(18) Center Contracting (PK)	(19) Acq Center of Excellenc	(20) AFMC/DO	(21) AF/TE	(22) DOT&E	(23) OSD	(24) SECAF/ CSAF	(25) Joint Staff	(26) DAB Participants	(27) DARPA	(28) AF Acq Exec	
(2) MAJCOM Requirements	0	0	1	1	0	1	1	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	1	1	1	0	0	13
(3) PEO	0	0	1	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	1	0	1	9
(4) Lead Acquisition Organization	1	1	0	1	1	1	1	1	1	0	0	1	1	0	0	1	1	1	1	1	1	0	0	0	1	1	1	19
(5) Milestone Decision Authority	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	0	1	12
(6) OSD/NII	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	10
(7) AFMC/LG	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
(8) MAJCOM LG	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
(9) OSD (AT&L)	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	10
(10) Industry	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	4
(11) Defense Intelligence Agency	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
(12) Combatant Commanders	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	6
(13) MAJCOM Budget	1	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	6
(14) SAF/AQX	0	1	1	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	6
(15) SAF/FM	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	4
(16) AF/XP	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	5
(17) Air Force Research Lab (AFRL)	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3
(18) Center Contracting (PK)	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3
(19) Acquisition Center of Excellence	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	5
(20) AFMC/DO	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	4
(21) AF/TE	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	7
(22) DOT&E	1	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	0	1	11
(23) OSD	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	8
(24) AF	1	0	0	1	1	0	0	1	0	0	1	0	0	1	1	0	0	0	0	1	1	1	0	1	0	0	1	12
(25) Joint Staff	1	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	9
(26) DAB Participants	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	11
(27) DARPA	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3
(28) AF Acq Exec	0	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	1	0	1	1	1	0	0	12

C. SYSTEM DEVELOPMENT AND DEMONSTRATION MANAGEMENT/DESIGN NETWORK

	(2) MAJCOM Requirements	(3) PEO	(4) Program Office	(5) Milestone Decision Authority (MDA)	(6) Congress	(7) AFMC/LG	(8) MAJCOM LG	(9) OSD (AT&L)	(10) Contractor	(11) Sub Contractor	(12) Vendor	(13) MAJCOM Budget	(14) SAF/AQX	(15) SAF/FM	(16) AF/XP	(17) OSD(C)	(18) Center Contracting (PK)	(19) Center FM	(20) Test Ranges	(21) AFOTEC	(22) Center CE	(23) Center HR	(24) DCMA	(28) AF Acq Exec	
(2) MAJCOM Requirements	0	0	1	1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	9
(3) PEO	0	0	1	1	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	1	9
(4) Program Office	1	1	0	1	0	1	1	0	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	1	17
(5) Milestone Decision Authority	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
(6) Congress	0	1	0	1	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	7
(7) AFMC/LG	1	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	6
(8) MAJCOM LG	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5
(9) OSD (AT&L)	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	6
(10) Contractor	1	1	1	0	1	1	1	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	1	0	11
(11) Sub Contractor	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	5
(12) Vendor	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3
(13) MAJCOM Budget	1	1	1	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	8
(14) SAF/AQX	0	1	1	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	6
(15) SAF/FM	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	4
(16) AF/XP	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	3
(17) OSD(C)	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3
(18) Center Contracting (PK)	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
(19) Center FM	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3
(20) Test Ranges	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4
(21) AFOTEC	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
(22) Center CE	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
(23) Center HR	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
(24) DCMA	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4
(28) AF Acq Exec	0	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	6

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